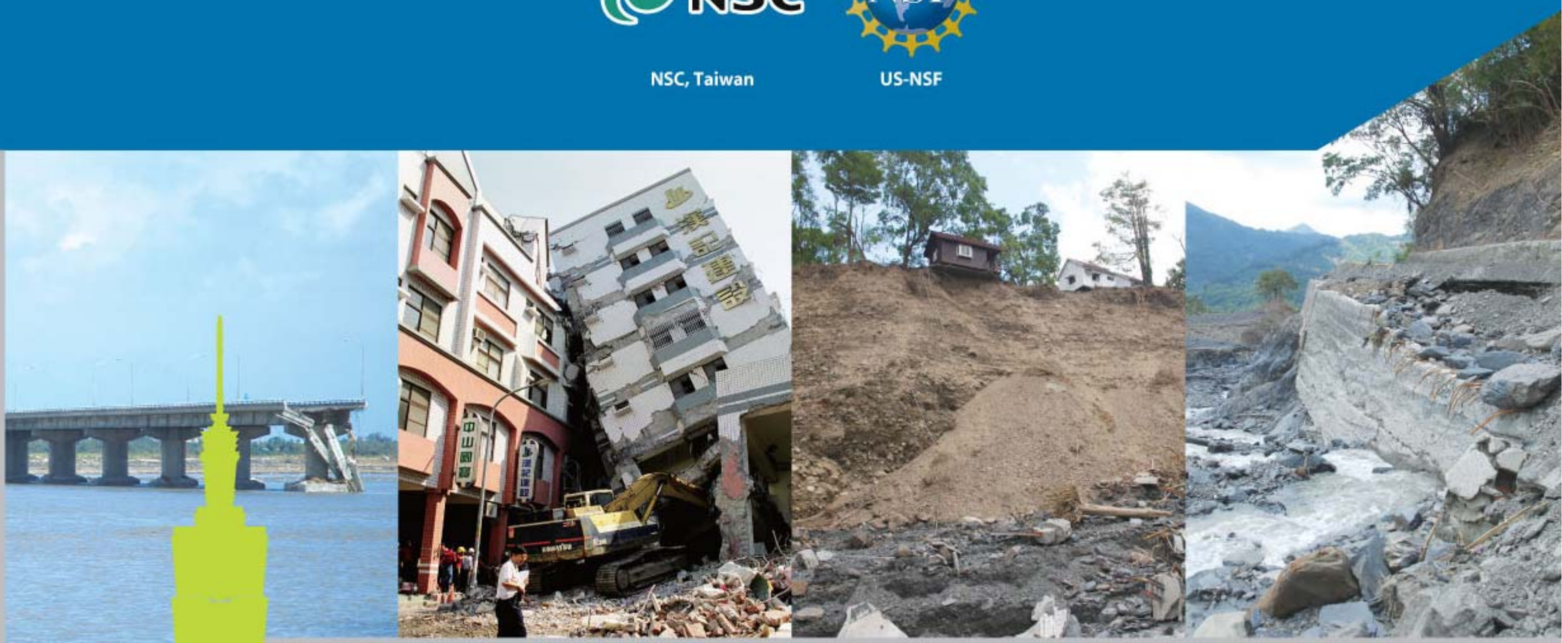
Proceedings of the US-Taiwan

Workshop on the Advancement of Societal Responses to Mega-Disasters Afflicting Mega-Cities

NSC, Taiwan

US-NSF



Taipei, Taiwan May 6-8, 2010

National Taiwan University

NCREE

國家實驗研究院
颱風洪水研究中心籌備處

Taiwan Typhoon & Flood Research Institute

Disaster Management Society of Taiwan

National Science and Technology Center for Disaster Reduction

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May 6 (Thursday)		
08:30-09:00	NCREE Lobby	Registration
09:00-09:20	NCREE 101	Opening Ceremony - Opening Speech by Dr. Lou-Chuang LEE, Minister of National Science Council, Taiwan
09:20-09:50	NCREE 101	Plenary Session - Keynote Speech by Michael F Goodchild, UC Santa Barbara, USA
09:50-10:20	NCREE 101	Plenary Session - Keynote Speech by William L. Carwile III, FEMA, USA
10:20-10:40		Coffee Break
10:40-11:10	NCREE 101	Plenary Session - Keynote Speech by Norden E. Huang, National Central University, Taiwan
11:10-11:40	NCREE 101	Plenary Session - Keynote Speech by Jenn-Chuan Chern, Public Construction Commission, Taiwan
11:40-12:30	NCREE 101	Plenary Session - Introductions of Participants, & Discussion prior to Group Breakout
12:30-13:30		Lunch Break
13:30-15:20	NTU-CE R-501, NCREE 101, 103, 410	Concurrent Sessions - Group Discussions
15:20-15:40		Coffee Break
15:40-17:30	NTU-CE R-501, NCREE 101, 103, 410	Concurrent Sessions - Group Discussions
18:00-21:00	Taipei World Trade Center Club	Banquet hosted by Dr. Cheng-Hong CHEN, Deputy Minister of National Science Council, Taiwan
May 7 (Friday)		
09:00-10:10	NTU-CE R-501, NCREE 101, 103, 410	Concurrent Sessions - Group Discussions

10:10-10:30		Coffee Break
10:30-12:00	NTU-CE R-501, NCREE 101, 103, 410	Concurrent Sessions - Group Discussions
12:00-13:30		Lunch Break
13:30-15:20	NCREE 101	Plenary Session - Group Concluding Remarks
15:20-15:40		Coffee Break
15:40-17:30	NCREE 101	Plenary Session - Group Concluding Remarks
May 8 (Saturday)		
8:30-16:00		Field Trip (for international guests only) – the National Palace Museum, and Taipei 101 Skyscraper (The charter bus will depart from Hotel Taipei Fullerton South at 8:30am.)

- ✓ NCREE 101 and 103 are NCREE's main lecture halls right next to its entrance lobby. NCREE 410 is on the fourth floor of NCREE building.
- ✓ NTU-CE (Street Address: 188 Section 3 Xinhai Rd.) is the new NTU Civil Engineering building sitting on the other side of NCREE's front yard. NTU-CE R-501 is on the fifth floor of the NTU-CE building.
- ✓ During concurrent sessions, **Working Group 1** (Methods to Forecast Natural Hazard Occurrence and the Impacts on Societal Systems) will meet at NTU-CE R-501.
- ✓ During concurrent sessions, **Working Group 2** (Technology to Increase Societal and Infrastructure Resiliency when Exposed to Major Natural Hazards) will meet at NCREE 101.
- ✓ During concurrent sessions, **Working Group 3** (Assessment Techniques to Quantify the Risk Posed to Individual Infrastructure and Systems of Infrastructures) will meet at NCREE 103.
- ✓ During concurrent sessions, **Working Group 4** (Post-event Management Plans that Minimize the Socio-economic Impact of Natural Hazards) will meet at NCREE 410.

Introduction

The economic prosperity of developed nations like the United States and Taiwan relies upon national networks of infrastructure systems. These include both physical infrastructure (roadways, bridges, pipelines, utilities) and the infrastructure of information and communications technologies (ICT) that are increasingly essential both to the functioning of modern societies and to effective emergency response. Indeed, physical infrastructure alone, in both its construction and maintenance, represents the largest societal investment in the US, outside of the health care industry. Yet, infrastructure systems have performed so well that they are often “taken for granted” until a catastrophic failure occurs, as witnessed by the collapse of New Orleans levees in 2005 or the I-35W Bridge in Minnesota in 2007. The economic impact of this specific bridge failure was staggering; it is estimated that the loss of this major transportation artery resulted in over $200M worth of business losses to commercial supply-chains. The failure of bridges in the U.S. is not as uncommon as the public may think. Even though bridges are inspected to ensure they meet minimal safety standards, collapses still occur. From 1989-2000, 134 bridges in the U. S partially or totally collapsed In addition, 13% of the national inventory is classified by the Federal Highway Administration as “deficient”; the same classification given to the I-35W Bridge prior to collapse. To compound the problem, the economic resources available to maintain our infrastructure are shrinking at an alarming rate; the Highway Trust Fund will be several billion dollars in deficit by year’s end.

Each year the United States and Taiwan sustain natural and manmade disasters that cost hundreds of lives and average billions of dollars in losses. These disasters are caused by floods, wildfires, winter storms, tornadoes, landslides, earthquakes, hurricanes, and other natural events, as well as intentional and unintentional manmade hazard events. These circumstances demand the attention of government at all levels, the private sector, and individuals, to take steps to decrease hazard risks. According to the World Commission on Environment and Development, sustainable development must meet the needs of the present without compromising the ability of future generations to meet their own needs. In sustainable communities, decisions made by the present generation will not reduce the options of future generations. The present generation should seek to pass on a natural, economic, and social environment that will provide a high quality of life. Some U.S. communities, devastated by hurricanes and other hazard events in the first 5 years of the millennium, have demonstrated that developed, populated hazard areas may not be sustainable.

Taiwan is situated in a highly seismically active region of the world with devastating earthquakes occurring almost every decade. The most recent serious earthquake to strike Taiwan was the Chi Chi Earthquake (1999) which resulted in 2,416 dead and over

NT$300 billion in structural damage. In addition to seismic hazards, Taiwan is situated along the primary path of Northwestern Pacific tropical cyclones. For example, Typhoon Morakot (2009) wrought catastrophic damage in Taiwan, leaving 461 people dead and 192 others missing, most of whom are feared dead and roughly NT$110 billion in damages. As a result, civil, mechanical, and ICT infrastructure systems in Taiwan must be designed to be resilient in the face of multiple categories of natural hazards including earthquakes, floods and extreme winds. A direct result of the extensive investment by the NSC is that Taiwan is a recognized leader in the hazard mitigation field, along with the U.S.

A framework for an integrated research frontier is envisioned to revitalize US-Taiwan collaboration on emerging areas serving pressing societal needs. The proposed program is focused on two fronts: (1) a global interest in the broad impact potential of multidisciplinary research in building and infrastructure resilience, and (2) reinforcement of bilateral interest as explicitly shown at the recent NSF-NSC annual meeting at the NSF in seeking new mitigation solutions for mega disasters such as catastrophic mega-earthquakes, hurricanes/typhoons, floods, and massive rock/mud/land slides.

List of Participants and Position Papers

(In alphabetical order of the author’s last name)

Candice Abinanti

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Candice Abinanti is an International Relations Specialist for the Federal Emergency Management Agency (FEMA). Candice works in the International Affairs Division, part of the Office of External Affairs at FEMA's headquarters in Washington, D.C. where she manages projects and coordinates collaborative activities with international and interagency partners.

Before joining the International Affairs Division, Candice worked for the FEMA Region I Mitigation Division in Boston. There she supported several national hazard mitigation grant programs and worked closely with State emergency management partners in New England. Candice has deployed to disasters throughout the United States as a hazard mitigation and Geographic Information Systems (GIS) specialist. In these capacities she supported the TOPOFF 3 national level exercise, the 2004 Republican and Democratic National Conventions, FEMA's response to the California wildfires in November 2003, and Hurricane Katrina recovery in Mississippi in 2005.

Prior to joining FEMA, Candice worked for the Massachusetts Emergency Management Agency. Earlier, she worked in the private sector for an educational travel company.

In 2006, Candice earned a Master of Arts degree in Sustainable Development from the School for International Training while living in Sri Lanka following the 2004 Indian Ocean Tsunami. Candice holds a Bachelor of Arts degree in Anthropology and a Certificate of Study in International Relations from the University of Massachusetts.

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International Relations Specialist

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Mega-City/Mega-Disaster Reduction

I grew up in the northeastern part of the U.S., where "small talk" with strangers and acquaintances typically includes much reference to the weather. The northeast is characterized by four distinct seasons and a long, cold, and damp winter. To me, this constant chatter about the weather reflects the understanding of a group of people aware that they are both part of and dependent upon their natural environment, not removed from it, as I often sense in our Mega-Cities.

With their robust infrastructure and buildings, Mega-Cities are human-made environments which I've observed have a tendency to distance their inhabitants from the natural environment and insulate them from its day-to-day variations and hazards through controlled indoor environments and engineered routes to move people and trade into, around, and out of the city expeditiously. Faced with a Mega-Disaster, a challenge I see for existing and emerging Mega-Cities is strengthening their inhabitants' awareness and understanding of the changing natural environment their city remains a part of, and leveraging that increased knowledge to socially prepare and physically re-envision more hazard resilient and adaptable cities.

In visualizing what tomorrow's more hazard resilient and adaptable Mega-Cities could look like, I think of cities of yesterday, the social systems, buildings, and infrastructure they are comprised of as relatively rigid, absorbing stress and force. I visualize cities of tomorrow with buildings and infrastructure more capable of flexing against environmental stresses and deflecting force, and systems more readily capable of adapting to change with minimal energy expenditure. Some examples of the science and technology that may comprise these cities of tomorrow already exist today for us to borrow and build upon.

- Floating homes and communities in the Netherlands that rise with flood waters.[1]
- Building and site design incorporating both traditional and modern ideas for increasing hazard resilience and energy efficiency and minimizing environmental impact. For example: thick walls high in thermal mass painted white, as in southern Europe, to reflect and absorb heat, and “green roofs” and roof gardens to reduce storm water runoff and cool the air.[2]

There is a saying that the tree that survives the hurricane is the one that’s learned to bend. I believe that Mega-Cities cognizant of the environment they are a part of, and equipped with social systems and infrastructure inherently capable of flexing to the stresses of that environment, will be the ones that withstand the Mega-Disasters of tomorrow.

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[1] Evans-Pritchard, Ambrose. (2004, September 8). Dutch find a cure for rising damp - a town full of floating houses. *The Daily Telegraph*. Retrieved April 5, 2010 from http://www.telegraph.co.uk/news/worldnews/europe/netherlands/1471274/Dutch-find-a-cure-for-rising-damp-a-town-full-of-floating-houses.html

[2] Lonsdale, Sarah. (2009, August 19). Eco home sweet home of the future? *The Daily Telegraph*. Retrieved April 5, 2010 from http://www.telegraph.co.uk/property/greenproperty/6042750/Eco-home-sweet-home-of-the-future.html

Adnan Akay

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Adnan Akay joined Bilkent University on January 1, 2009 as Vice President and the founding head of Mechanical Engineering Department. He moved to Bilkent from the U.S. National Science Foundation where he was the director of the Division of Civil, Mechanical and Manufacturing Innovation Division. Between 1992 and 2005 Dr. Akay was the head of the Mechanical Engineering Department at Carnegie Mellon University where he currently holds the title of Lord Professor of Engineering. Prior to joining Carnegie Mellon, he was on the faculty at Wayne State University, where he last held the DeVlieg Chair in Engineering, and prior to that he was with the National Institutes of Health. He has held visiting appointments at several universities and continues to collaborate with colleagues at the University of Rome "La Sapienza," and Institut National des Sciences Appliquées (INSA) de Lyon in France. He also serves as an advisor to numerous companies and universities. Adnan Akay's research area is in acoustics, vibrations, dissipation theories and friction. He has been recognized with several awards including the Per Brüel Gold Medal in Acoustics and Noise Control in 2005 from ASME. He is a Fellow of the American Society of Mechanical Engineers and the Acoustical Society of America.

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Mega-Cities, Mega-Disasters and Disaster Mitigation

Mega disasters result when a natural mega event, such as a high intensity earthquake, typhoon, hurricane or Tsunami, or a human-induced large-scale event strikes a mega-city, possibly leading to multi-event catastrophes. Multiple events such as fires, floods, breakout of diseases, and release of toxins to the environment start a chain reaction of failure of services, communication and transportation and other similar life lines of a mega-city. Together with such physical failures, loss of human life and human suffering, long-term disruption of life in general lead to a mega-disaster.

From the viewpoint of disaster mitigation or reduction, mega-disasters may be considered in three parts. Before, during, and after a mega event becomes a mega-disaster. All the training, education, and preparedness that take place can help mitigate the scope of the disaster with appropriate responses by everyone. Such preparedness requires close collaboration of technical, social, and legislative components of a civil society. Focusing only on the engineering aspects, vulnerabilities of infrastructure need to be identified and strengthened to reduce the possibility of a chain reaction of events.

Strengthening the widespread vulnerabilities that exist in many of the well established mega cities require resource that may not be readily available and, thus, requires mega will supported by sound risk assessment methodologies.

When considered from a technical viewpoint, a mega event consists of energy build-up, energy transport, and energy dissipation. The engineering aspects of energy release or dissipation at a mega-city involves infrastructure and has been well considered. The forecasting of natural mega events still needs further understanding, particularly, of the source during energy build-up and release.

Since different mega events have different time scales during which energy is built up and transported, they need different considerations. For instance, the ratio of the time it takes to build up energy before an earthquake to the time it takes to deliver it is inverse of, say, that of a hurricane. Notwithstanding the slower development of energy build up before an earthquake, forecasting it with a useful lead time and certainty is still not available. As an example of what can be investigated, the relative motion at the fault lines exhibit “micro” stick-slips that have been measured using sensors placed deep in earth. These are not unlike micro stick-slip that develops between the flat surfaces of two solid bodies. A better understanding of the latter may lead to the same of the former.

William L. Carwile III

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Bill Carwile served as Federal Coordinating Officer (FCO) and in other senior management positions on large federal disaster response operations between 1996 and 2005. As FCO he served as the representative of the President and DHS - FEMA during major disaster and emergency declarations, orchestrating federal resources and programs in support of state governors. Prior to becoming a full-time FCO, he served as the Director, Pacific Area Office, FEMA Region IX.

Mr. Carwile's emergency management leadership experience includes such large-scale disasters as Super Typhoon Paka in Guam; Hurricane Georges in Puerto Rico; Tropical Storm Allison in Louisiana; the New York City World Trade Center response; Super Typhoon Chataan in Guam; California Wildfires and responses and recovery efforts for the four hurricanes that struck Florida in 2004. During Hurricane Katrina, he served as the FCO for the Mississippi response. In these and all other disasters, he demonstrated his full understanding of the supporting role of the federal government with state and local officials, and focused on building and maintaining strong intergovernmental and interagency partnerships.

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Planning for a "Whole Community" Response to a Worst Case Catastrophic Event

In today's global environment, we all face hostile nation states, terrorist groups, pandemic influenza outbreaks, and the entire gamut of manmade and natural disasters. At FEMA, we stand ready to respond immediately to all types of emergency situations and disasters to deliver needed assistance to protect the health and safety of the survivors.

An incident of catastrophic proportions has the potential to imperil millions of people, devastate multiple communities simultaneously, and create far-reaching economic and social effects. In such events, the scope of needs will be large, immediate, novel and profound, and the entire national emergency management, public health, security, law enforcement, critical infrastructure, medical and all other components in the Federal, state, local, tribal, private and public sectors that make up the "whole community" must be prepared to respond in ways that lie outside the normal paradigms in which we have traditionally operated.

National efforts to ensure resilience in the U.S. are focusing on improving existing catastrophic event preparedness capabilities, but with a renewed conviction to plan for the most extreme disasters. We are building on the strengths of local communities and citizens and integrating the public as a critical resource and definite part of the solution. The faith based communities, fraternal and trade associations, and the broader marketplace are all viewed as important to collaboration and are included in the planning efforts. While the impact of catastrophes will certainly be felt at the Federal and state level, the impacts have the potential to be most devastating at the community level. Therefore, our catastrophic response strategy is being designed to quickly stabilize communities, and calibrated to support their timely recovery and return to municipal self-sufficiency. We recognize that only through close cooperation with all partners can we begin to close gaps and agree on the most critical objectives. Engaging the “whole community” is essential.

FEMA is coordinating and facilitating development of detailed horizontally and vertically integrated catastrophic response plans for earthquakes, hurricanes, biological attacks and other threats. Our planning assumptions for catastrophic disasters are based on the “maximum of maximums” or worst case scenarios and are designed to challenge preparedness at all levels of government, and force innovative, non-traditional solutions as part of the response strategy to such events. A planning effort currently underway in the U.S. is focused on a catastrophic earthquake impacting eight states in the New Madrid Seismic Zone. This initiative integrates plans at all levels of government with an overarching national-level earthquake plan and is providing the basis for a fundamental re-tooling of all-hazards catastrophic incident guidance.

In conclusion, effectively and rapidly responding to and recovering from the impact of a catastrophic disaster is one of the greatest challenges faced by all levels of government. In the U.S., we are taking planning and preparedness to a higher level and will not accept the easy way out. We recognize our success depends on the collective and collaborative efforts of the “whole community” and we can accept nothing less if we are to provide stronger and more agile disaster response capabilities.

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K.T. Chau is the Chair Professor of Geotechnical Engineering of the Department of Civil and Structural Engineering at the Hong Kong Polytechnic University. He is also the Associate Dean of the Faculty of Construction and Land Use. He obtained his Honours Diploma with distinction in Civil Engineering from the then Hong Kong Baptist College, Master of Engineering in Structural Engineering from Asian Institute of Technology (AIT) (Thailand) with the Tim Kendall Memorial Prize (academic award), and PhD in Theoretical and Applied Mechanics from Northwestern University (NU) (USA). He has worked as research associate at AIT, and research assistant and post-doctoral fellow at NU. He has been a visiting professor or fellow to University of Calgary (Canada), Lille Polytechnic (France), Kyoto University (Japan), and Harvard University (USA). He is a Fellow of the Hong Kong Institution of Engineers (HKIE), the Chairman of TC103 (Numerical Methods in Geomechanics) of the ISSMGE, and the Chairman of the Geomechanics Committee of the Applied Mechanics Division (AMD) of ASME. He is a former president of the Hong Kong Society of Theoretical and Applied Mechanics. His research interests was in geomechanics and geohazards, including earthquake, landslides, storm surges, tsunami, and rockfalls.

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How Reliable is Our Existing "Seismic Hazard Analysis"?

Major earthquakes in recent years repeatedly reveal that our existing seismic hazard maps have been unable to reliably estimate seismic hazard. For example, the seismic risk due to dynamic rupture of the Nojima fault has been underestimated before the 1995 Kobe earthquake in Japan, not much attention was paid to Chelungpu fault before the 1999 Chi-Chi earthquake in Taiwan, and potential seismic risk induced by Longmenshan fault has been ignored before the 2008 Wenchuan earthquake in Sichuan. For example, the estimated hazard level of PGA is only 0.1g (at least exceeding once in 475 years) at Yingxiu and Beichuan while the 2008 Wenchuan earthquake actually induced shaking of 0.6g to 1g in these two areas (Wen et al. 2010). We have to ask ourselves how reliable our existing hazard analysis is. The original Cornell's method assumes earthquake occurrence as a Poisson process (i.e. all earthquakes are independent of one another), and common sense tells us that this is clearly untrue. We rely heavily on the past records to establish the probability of earthquake occurrence which is used in hazard analysis, but with our limited data in earthquake catalogue in geological history our estimation of earthquake probability is inevitably to be inaccurate. For example, the maximum historical earthquake (within the last 2000 years) occurred in Longmenshan fault is only 6.2, and because of this the seismic hazard has been severely underestimated. Therefore, the 2008 Wenchuan of Ms 8.0 (Mw 7.9) is to the surprise of many seismologists. We desperately need a better method of "hazard analysis".

Reference:

Wen Z.P., Xie J.J., Gao, M.T., Hu Y.X. and Chau K.T. (2010). "Near-Source Strong Ground Motion Characteristics of the 2008 Wenchuan Earthquake" *Bulletin of Seismological Society of America*, accepted (in press).

Liang-Chien Chen

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Liang-Chien Chen is a professor in the Center for Space and Remote Sensing Research at National Central University. He graduated from National Cheng-Kung University, Taiwan, in 1972. He received the M. S. E. and Ph. D. degrees from the Department of Civil Engineering, NCKU, in 1974, and the Department of Civil Engineering, University of Illinois, Urbana, in 1985, respectively. He joined the institute of Photogrammetry, NCKU, as an Associate Professor from 1985-1986. He has been with the Center for Space and Remote Sensing Research, National Central University, Jhongli, Taiwan, as an Associate Professor from 1986-1993 and full Professor from 1993 up to date. He was appointed as the Director of CSRSR in 1995 for three years. He is currently in charge of the Satellite Ground Receiving Station, which is a major part of satellite remote sensing infrastructure in Taiwan. His research activities are in the areas of digital photogranmetry, geometrical data processing for remotely sensed data, image feature extraction, three-dimensional object reconstruction, and cyber city modeling. He has been awarded the distinguished professor since 2006. Dr. Chen is the Chairman of the Academic Committee of the Chinese Taipei Society of Photogrammetry and Remote Sensing. He joins a number of editorial boards of photogrammetry and remote sensing related journals.

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Multi-Sensor-Grammetry in Hazard Mitigation for Mega Cities

The World Bank has recorded Taiwan as the most vulnerable country in terms of the multiplicity of natural hazards. For decades, Taiwan has suffered from many natural disasters, such as typhoons, earthquakes, floods, and others. Hazard mitigation, thus, becomes an important task in Taiwan. Metropolitan Taipei is without exception.

From geoinformation point of view, spatial data inventory is an important part for preventive mitigation, while fast information gathering is a must for fast response. Over the decades, the governmental agencies and private sectors in Taiwan have invested largely in data acquisition for land information. Space borne systems for instance, we have launched our own Formosat-2 satellite that provides 2m resolution images with daily revisit. The satellite ground receiving station has been running since 1993, which receives SPOT series, ERS/Envisat, MODIS (Terra/Aqua), and many other images.

More significantly in the last decade, 6 large format digital cameras (Vexcel, Z/I, Leica) have been flown frequently. The airborne Lidar systems are energetic, too. There are 4 such systems (Optech, Leica) operated with the complement of medium size (> 20M pixels) digital cameras. In addition, an airborne SAR sensor will be operated within one year. The sensor will provide one meter resolution images in all weathers. Those powerful data gathering systems provide solid backup for hazard mitigation. A new operation mechanism to effectively integrate those separate systems becomes an important work for fast response when disasters occur. For urban areas, data modeling with sufficient details is important in hazard mitigation. Since 1/1,000 scale topographic mapping is a standard in the geoinformatic infrastructure, 3D modeling should be considered for the decades to come. City GML LOD 2 building models for a city environment has gradually become a consensus in Taiwan. Micro GIS, i.e., LOD4, has been suggested by some universities for special building complex.

The damages of natural disasters are getting more serious as the drastic weather occurs frequently. More sophisticated technologies are needed to encounter the harsh challenges. The applications of the state-of-the-art spatial information technologies are indispensable. How to integrate and enhance the data acquired from heterogeneously sensor systems becomes an important task for the experts in the area.

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Yue-Gau Chen is a professor in the Department of Geosciences at the National Taiwan University. He received his Ph.D. degree in Geosciences from the National Taiwan University. He had been a visiting scholar at Purdue University, U.S.A. He had also been Research Associates at Geosciences of National Taiwan University during 1997-2003. He was the Committee Member of International Lithosphere Program in Taiwan during 2001-2005, and NSC Panel committee of Earth Sciences Study during 2004-2005. He also was the Convener of NSC Panel committee of Earth Sciences Study during 2006-2009. Dr. Chen research interests include Neotectonics, Quaternary Geochronology, Stable Isotope Geochemistry and Quaternary Geology. Dr. Chen received NSC outstanding research award from 2003 to 2006. Dr. Chen also received the GSA fellow elected in 2008, and he is the only scholar from Asia.

Cheng-Hsing Chen

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Cheng-Hsing Chen is a professor in the Department of Civil Engineering at the National Taiwan University. He received his Ph.D. degree in Civil Engineering from the University of California, Berkeley in 1984. He entered the National Taiwan University in 1985 and became a full Professor in 1989. Now he also serves as the Head of the Geotechnical Division in the National Center for Research on Earthquake Engineering, Taiwan. Dr. Chen's research interests include Geotechnical Engineering (pile foundation, deep excavation, and shield tunneling), Earthquake Engineering (soil-structure interaction, site response and soil liquefaction), and environmental vibration and control. He received NSC outstanding research award from 1993 to 1994, the Award of Excellent Teacher of Ministry of Education in 1987, and the Awards of Excellent Teacher of National Taiwan University in 1999 and 2000. In 2009, Dr. Chen was appointed as the President of the Sino-Geotechnics Research and Development Foundation.

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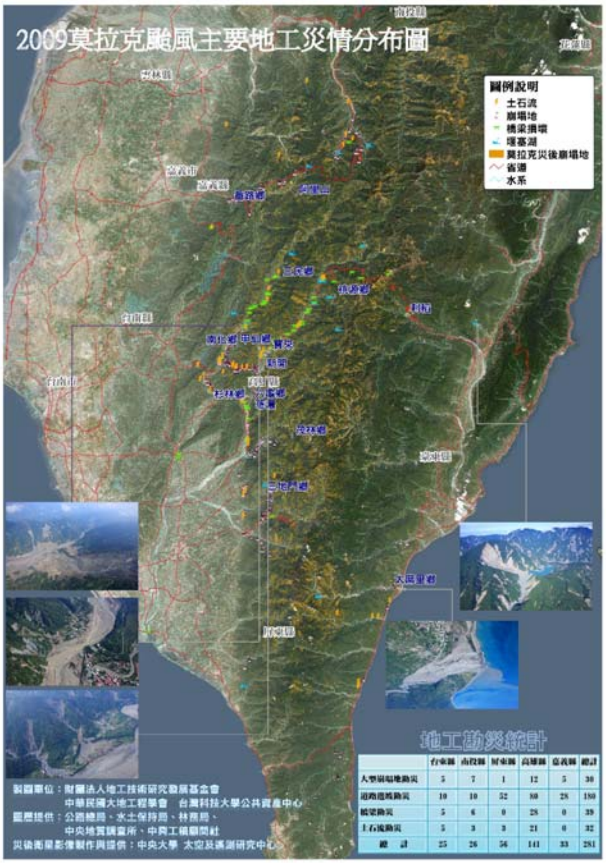
Geotechnical Damages Resulted by the Morakot Taiphoon in August 2009

During the Morakot Taiphoon of Aug. 2009, the Southern Taiwan suffered the extraordinary rainfalls, reached as high as 3000mm at some locations. Numerous landslides and debris destroyed the roadways, bridges and residential houses. Besides, a lot of embankments were damaged and a wide area was flooded. Due to the severe damages resulted, a reconnaissance team was initiated and formed by the Taiwan Geotechnical Society and the Sino-Geotechnics Research and Development Foundation for detailed investigations. All the results of investigation were detailed recorded and mapped into the GIS. The results were summarized and published by Sino-Geotechnics R&D Foundation, along with a disastrous map.



Ming-Dean Cheng

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Ming-Dean Cheng became the Director of the Weather Forecast Center (WFC) of CWB on November 2, 2009 after serving as the Director of the Research and Development (R&D) Center of CWB since October 1, 1993. The WFC is responsible for the daily operational weather forecasts in Taiwan, while the R&D Center conducted a couple of research projects focusing on typhoon-track prediction and heavy rainfall weather systems. The R&D Center also offers the administrative supports of CWB for all aspects of its research projects, annual conference, Journal publication, and on-job training programs, etc.

Dr. Cheng received his undergraduate education at the National Taiwan university. He attended the graduate school at UCLA in 1982 and later obtained his Ph.D. degree on Atmospheric Sciences on the Fall of 1987 under the supervision of Professor Yanai. He worked for Professor Arakawa as a postdoctoral researcher in the same department at UCLA before he joint the Advanced Study Program at the National Center for Atmospheric Research at Boulder, Colorado on the Spring of 1989. His research interest is on the general area of cumulus parameterization for the use in a General Circulation Model especially on the inclusion of convective downdrafts in the Arakawa-Schubert cumulus parameterization. He returned to Taiwan and work for CWB on November, 1991.

Ming-Dean Cheng

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Severe Weather Monitoring and Forecasting at the Central Weather Bureau

Weather forecasts always involve a great deal of uncertainties. Even with modern weather monitoring and forecasting tools, there are always chances that weather forecasters might miss or underestimate the significance of a potentially hazardous weather event. Especially, it usually takes a set of coincidences to make a “perfect storm so that some degree of forecast surprise is almost unavoidable. Therefore, to support the disaster mitigation operation, it is important to have at hand sophisticated real-time extreme weather monitoring system along side with traditional weather forecast systems and an effective and timely information dissemination system. At the Central Weather Bureau (CWB), a QPESUMS QPESUMS (Quantitative Precipitation Estimation and Segregation Using Multiple Sensor) system is developed to provide real-time, high resolution QPE (Quantitative Precipitation Estimate) with auto-warning capability. A set of nowcasting tools is also implemented into QPESUMS to assist forecasters to handle severe weather monitoring and forecasting problems. All information generated by the QPESUMS is disseminated to central and local disaster mitigation offices automatically by dual communication channels.

Ching-Churn Chern

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Ching-Churn Chern is a professor emeritus in Department of Civil Engineering at National Taiwan University since 2002. He received his B.S. and M.S. degrees in Civil Engineering from National Taiwan University in 1960 and 1964 respectively, and received another M.S degree major in Structural Mechanics from Department of Civil Engineering at Northwestern University, USA in 1976. He has been joining the teaching and researches in the Department of Civil Engineering at National Taiwan University since 1964 for longer than 45 years. He was the Director of Earthquake Engineering Research Center at National Taiwan University during 1980-1985, and the Director of Taiwan Construction Research Center in 1985-1988. His research interests are in the areas of structural hazards mitigation, structural health monitoring, and assessments on the structural stability and structural ultimate capacity.

Ching-Churn Chern

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Professor Emeritus

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Advanced Studies on Health Monitoring and Warning System for Electric Power-Transmission Towers

The safety and stability of the steel towers essentially influence the reliability of electric power supply of transmission lines in Taiwan. These steel truss towers are composed of suspension towers, strain towers and terminal towers. The identification of structural damage is essential purpose of structural health monitoring for these towers. The dynamic behaves for healthy towers and damaged towers have to be studied at very beginning. Also the ultimate strength or maximum capacity of towers in resisting strong earthquake or strong wind dealing with elasto-plastic deformations, dynamic behavior and stability should be assessed very carefully type by type. The warning system could be studied and established primarily by applying the on-line recursive and identification technique by applying such as HHT (Hilbert-Huang Transformation) adaptive data analysis methods, etc. The series research works for the related towers should be established for a long investigation.

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The Strategies and Post-Disaster Reconstruction of Typhoon Morakot in Taiwan

On the seventh of August, Typhoon Morakot brought its copious rainfall to the southern Taiwan with the rainfall amount up to 2,965 mm recorded in Alishan. This record breaking rainfall, combined with untimely high tides, kept the water ever rising, gradually building into a catastrophe. There were 699 deaths and missing, and over 8,000 left homeless. Six major highways were seriously damaged and several isolated islands in high mountain area were formed under the torrential rains. After the assessments of safety of townships and villages in high mountain areas, half of villages lived by indigenous people were ranked as unsafe in 90 sites investigation.

In order to deal with the recovery and reconstruction of the Morakot disaster, the government took the immediate measures to face the challenges. Morakot Typhoon Post-Disaster Reconstruction Special Act was approved by Congress on August 28 and declared by the President on August 29, 2009. The Act was used as the amendment to the “Disaster Prevention and Protection Law”. The Morakot Post-Disaster Reconstruction Council of Executive Yuan was formed on September 12, 2009. The budget for the reconstruction plan is NT$ 120 billion and was declared by the President on Nov. 20, 2009. Another NT$ 35 billion was added from reallocated annual budget for immediate relief.

There were four reconstruction plans developed including regional reconstruction plan with land conservation guidelines, civil infrastructure reconstruction plan、community reconstruction plan & industry reconstruction plan then follow the rule of respecting the Nature, escaping from disaster, river basin integration, as the foresight action. This lecture will present the efforts Taiwan has devoted in the first half a year after the typhoon. The reconstruction strategies and execution results will be introduced in this lecture.

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Recent Development of Post-Tensioned Self-Centering Structures for Earthquake Resistance

A post-tensioned (PT) self-centering (SC) structure that uses post-tensioning steel to compress beams against columns or bridge column segments against a footing has been developed as an alternative to a traditional earthquake-resisting system. The approach in seismic design, developed under the U.S. PRESSS program for precast concrete buildings with the SC connections, was verified from a 3/5 scale five-story SC concrete test-building (Priestley 1991, Pampanin et al. 2000). The SC behavior of the test-building was extremely satisfactory without significant strength loss up to drift levels of 4.5%. This posttensioning technology was successfully extended to steel moment-resisting frames (MRFs) by several connection tests (Ricles et al. 2002, Christopoulos et al. 2002). The lateral deformation of the PT frame leads to the opening of the gap at beam-to-column interfaces, so the compression force in the PT beam is affected by the column and slab restraints that oppose the frame expansion. These two issues become sources to hinder the SC behavior expected for this system.

Various conceptual proposals have been made along this line. Recently, Chou et al. (2008) experimentally showed that the PT connection with a continuous composite slab self-centers with low residual deformations as long as the metal deck separates along the column lines and negative connection moments provided by the slab reinforcements are considered in design. Chou et al. (2009) also demonstrated similar cyclic responses between a bare PT connection and a composite PT connection with a fully discontinuous composite slab, which opens freely along the beam-to-column interface. By adopting a concept of the rigid bay to transfer floor inertia forces to the PT frame and accommodate PT frame expansion (Garlock et al. 2006), shake table tests of a 3-dimensional PT frame with a sliding slab demonstrated the SC seismic response and small residual drift of the specimen frame in earthquake loadings (Chou and Chen 2009).

Kim and Christopoulos (2008) outlined the column restraining effect and suggested a pinned boundary condition for upper story columns to estimate column bending stiffness. The assumption of pinned boundary conditions represents a simplified estimate that represents an upper bound of this restraining effect and was suggested to account for the worst case scenario where a structure responds with a high drift at one floor while the drifts in the floors above and below are almost zero. Note that when the structure responds in its first mode shape (common seismic response for regular low-to-medium rise buildings) where all stories have comparable drifts, the restraining effect might be greatly reduced because the columns are pushed out at all floors simultaneously. Therefore, the previously approximate approach is overly conservative in cases where the structure responds in its first mode. Chou and Chen (2009) presented an alternative method for evaluating bending stiffness of the columns and compression forces in the beams based on a deformed column shape that matches the gap-opening at each beam-to-column interface. This method was verified analytically and experimentally through a full-scale one-story PT test-frame (Chou and Chen 2010).

It is easier to apply the posttensioning technology to bridge columns than buildings due to lack of restraints from the superstructure. In the past few years, research activities on the seismic responses of concrete segmental columns have been carried out in the U.S. and in other countries (Billington et al. 1999, Chang et a. 2002, Hewes and Priestley 2002, Chou and Chen 2006, Chou and Hsu 2008, Ou et al. 2007). Several test and analytical results of the PT segmental columns demonstrated the SC capability and good energy dissipation, but the application of this system in high seismic areas is still limited.

References

Billington SL, Barnes RW, Breen JE. A precast segmental substructure system for standard bridges. *PCI J.* 1999, 44(4): 56–73.

Christopoulos C, Filiatrault A, Uang CM, and Folz B. Posttensioned energy dissipating connections for moment-resisting steel frames. *J. Structural Engineering*, ASCE 2002; 128(9): 1111–1120.

Chang KC, Loh CH, Chiu HS, Hwang JS, Cheng CB, Wang JC. Seismic behavior of precast segmental bridge columns and design methodology for applications in Taiwan. Area National Expressway Engineering Bureau, Taipei, Taiwan, 2002 (in Chinese).

Chou CC, Chen YC. Cyclic tests of post-tensioned precast CFT segmental bridge columns with unbonded strands. *Earthquake Engineering and Structural Dynamics,* 2006, 35, pp. 159-175.

Chou CC, Hsu CP. Hysteretic model development and seismic response of unbonded post-tensioned precast CFT segmental bridge columns. *Earthquake Engineering and Structural Dynamics,* 2008, 37, 919-934.

Chou CC, Weng CY, Chen JH. Seismic design and behavior of post-tensioned connections including effects of a composite slab. *Engineering Structures,* 2008; 30: 3014-3023.

Chou CC, Tsai KC, Yang WC. Self-centering steel connections with steel bars and a discontinuous composite slab. *Earthquake Engineering and Structural Dynamics,* 2009; 38(4): 403-422.

Chou CC, Chen JH. Column restraint in post-tensioned self-centering moment frames. *Earthquake Engineering and Structural Dynamics,* 2009 (available online 2009/11).

Chou CC, Chen JH. Shake table tests of a steel post-tensioned self-centering moment frame with a composite slab accommodating frame expansion. *Proceedings of 5th International Symposium on Steel Structures*, Seoul, Korea. 2009.

Chou CC, Chen JH. Tests and analyses of a full-scale post-tensioned RCS frame subassembly. *J. Constructional Steel Research* (accepted for publication, 2010/4).

Garlock MM, Liu J, and King A. Construction details for self-centering moment resisting frame floor diaphragms. *U.S. Taiwan Workshop on Self-Centering Structural Systems*, Taipei, 2006.

Hewes JT, Priestley MJN. Seismic design and performance of precast concrete segmental bridge columns. *Report No. SSRP 2001/25*. University of California San Diego, La Jolla, CA, 2002.

Kim HJ, Christopoulos C. Seismic design procedure and seismic response of post-tensioned self-centering steel frames. *Earthquake Engineering and Structural Dynamics* 2008, 38 (3), 355-376.

Ou YC, Chiewanichakorn M, Aref AJ, and Lee GC. Seismic performance of segmental precast unbonded posttensioned concrete bridge columns. *J. Struct. Eng.,* ASCE. 2007; 133(11): 1636-1647.

Priestley MJN. Overview of the PRESSS research program. *PCI J.*, 1991, 36, 50-57.

Pampanin S, Priestley MJN, Sritharan S. PRESSS Phase 3: the five-story precast test building-frame direction response. *Report No. SSRP 2000/08*, University of California San Diego, La Jolla, CA, 2000.

Ricles JM, Sause R, Peng SW, and Lu LW. Experimental evaluation of earthquake resistant posttensioned steel connections. *J. Structural Engineering*, ASCE 2002; 128(7): 850–859.

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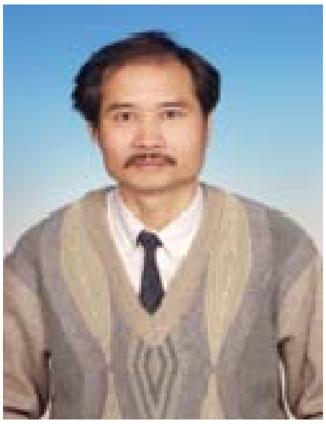

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Seismic Upgrading of School Buildings

Lap-Loi Chung and Shyh-Jiann Hwang

A number of buildings in the elementary and secondary schools in Taiwan have suffered damages of various degrees during earthquakes in past decades. Taiwan was so fortunate that the most devastating Chi-Chi earthquake occurred in late night otherwise the casualties could have been much more. From the past earthquakes, school building was found the most vulnerable category in public buildings. However, school buildings are usually assigned as emergency shelters. Therefore, seismic upgrading of school buildings becomes a stringent issue.

Since Chi-Chi earthquake in 1999, the National Center for Research on Earthquake Engineering (NCREE) has been devoted in the research and development on seismic evaluation and retrofit of school buildings. After a series of investigation through theoretical derivation, numerical simulation, laboratory experiment and in situ experiment, technology handbook on seismic evaluation and retrofit of school buildings was published for engineers.

In order to effectively tackle the seismic deficiency problems for school buildings in Taiwan, three stages have been proposed for screening, including simple survey, preliminary evaluation and detailed evaluation. All the data are submitted to the NCREE through internet. Seismic performance of school building is graded according to the ratio of seismic capacity and demand. Statistical analysis is carried out and the results are used for decision making by the education officials. The first stage of screening, simple survey is conducted by school administrators. School data and building data are collected. The second stage of screening, preliminary evaluation is conducted by professionals. It takes about half a day and costs about NT$6000 for preliminary evaluation of a school building. The third stage of screening, detailed evaluation is the conducted by professional engineers. It takes about 45 to 60 days and costs about NT$150 per square meter of floor area for detailed evaluation of a school building.

Retrofit design is conducted by professionals. It takes about 45 to 60 days and costs about NT$150 per square meter of floor area for retrofit design of a school building. Detailed evaluation and retrofit design must be reviewed by a panel to guarantee the quality of engineering works. Retrofit implementation is conducted by qualified contractors. It takes about 60 days and costs about NT$4000 per square meter of floor area for retrofit implementation of a school building. Inspection is required.

In response to financial tsunami, NT$558.3 billion was allocated for strengthening local infrastructure to expand domestic demand and for economy stimulus to expand investment in public works. Out of NT$558.3 billion, NT$18.3 was billed for seismic upgrading of buildings in elementary and secondary schools in four years, from 2009 to 2012. In this project, thousands of school buildings will go through the processes of preliminary evaluation, detailed evaluation, retrofit design and retrofit implementation. About 1500 school buildings will be retrofitted.

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Mega-Cities/Mega-Disasters

There are a number of recent natural disasters that can be used as examples to underscore the lack of advanced planning, the inability to quickly respond, the lack of coordination among differing agencies and organizations, the loss of needed lifelines (ranging from communication, food, water, electricity, health services, and sanitation) and other basic needs (public safety of fire, police & emergency response), not to mention the longer term issues of rebuilding. In a recent study of southern California medical services, it was found that only 29% of the hospitals in Los Angeles had a surge capacity that exceeded 20 beds. Sixty percent of the hospitals had to divert patients to other hospitals at least 20% of the time, because of the lack of capacity and less than half of the hospitals maintained more than 10 isolation rooms. Over the past decade, the number of pediatric beds declined by 19%, even when the child population increased. Now, it is common that hospitals move very sick pediatric patients from their hospitals in order to make way for even sicker children, due to the lack of free beds. What one can conclude from these facts is that the hospital system could not respond to a large influx of patients due to an emergency, regardless of the need (pandemic, earthquake, etc.). In fact, the lack of local capacity to handle anything out of the norm has been lost. The reason for this is that there are no incentives to provide emergency capacity. This means that outside emergency response capabilities are as important in LA as in Banda Aceh.

Susan Cutter has developed a social vulnerability index (SoVI) to hazards, but what are lacking are metrics for net emergency needs for an area as well as metrics of the capability of meeting those needs locally, regionally, and nationally. To explain this further, how long would it take to inspect bridges in LA after an earthquake and where would these inspectors come from? How long would it take to set up emergency medical service hospitals and how could they be accessible across a city? These types of measurements would need to be made across spatial and temporal domains and would help in making an appropriate response to a disaster. Developing disaster response capability metrics would also be helpful in advanced planning, in order to arrange appropriate shelter capacity and supplies storage to reduce the emergency needs (not supplied by local resources) to a level that can be supplied in a timely way from resources outside the region of the disaster.

Haphazard/ad hoc response to an emergency may fritter away limited resources and contribute to the overall problem, rather than mitigate it. It is clear that in past disasters (e.g. Haiti) the transport of water and food to places of high demand were hindered by choke points in the transport/supply system. Even building temporary housing and sanitation services (e.g. latrines) has been slow enough that Haitians are now experiencing the spring rainy season with little protection. The effects of this disaster will play out in slow motion for months and years to come, as the ability to handle the basic needs has been constrained by infrastructure, transport, and capital resources. We need better models for optimizing the delivery of disaster resources, planning and designs to provide enough resilience in infrastructure to ensure access/delivery of needed supplies, backup systems for communication, etc. In fact, even the placement of tent cities should be carefully thought out so that their locations can be easily supplied, rather than adding to the logistics problems already generated by the disaster. It is clear that a concerted, long term effort should be funded in disaster research, planning, mitigation, and infrastructure design.

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The Need to Plan for Recovery

The most under-investigated aspect of a disaster is the recovery phase. Unfortunately for many disasters in the United States the same impediments to recovery are faced time-and-again, and yet so many aspects are translational. This is especially true from a spatial perspective where the processes of mitigation and exposure are likely to reveal patterns on the landscape that will impact recovery. For example, consider the following recovery focused questions:

How can cities work through the “recovery gap”, the difference between accessible funds to rebuild and the actual money required – *at a community / street / individual building scale*? If there is an underlying social process then these recovery gaps should reveal spatial patterns. Can these patterns be used to predict recovery impediments even before a disaster?

How does urban health vulnerability influence recovery, either directly or indirectly through reduced mitigation and increased exposure? Again, can mapped patterns of health vulnerability be used to reduce both exposure and recovery impediments?

Is there a spatial pattern of recovery at the finest scale that influences return or subsequent abandonment? For example, should government funded recovery only occur in clusters, and if so, what is the minimum number of residences required to be successful?

Are there lessons to be learned from past disasters in terms of how communities react, how disparate wishes at town hall meetings can be reconciled, and how different recovery funds can be accessed? One would think so even though evidence suggests most disasters result in the reinventing of the wheel.

A common theme to these problems is one of geographic scale – although recovery plans for a megacity will obviously involve city, state and federal oversight, it could be argued that equally important is the understanding and empowerment of neighborhoods. Recovery cannot be evenly distributed – a prioritization of resources is required. How does that prioritization occur? Should there be a spatial frame to this organization based on the three previously mentioned recovery impediments?

In order to answer these questions academics need to be more fully involved in studying the recovery process. Unfortunately there are challenges to such work. Fine-scale data are required in order to assess recovery patterns, and make comparisons to pre-event baselines. These data may not be available or the researcher faces data release impediments. Fine-scale post-event infrastructure and building data are also hard to acquire, either originating from the immediate post-disaster period or as an assessment of building level recovery through time. New forms of fine scale spatial post-disaster data collection have been developed, yet many "academically-important" data sets are collected by FEMA and their contracting companies – the majority of which will never be accessible by academics.

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Dr. Cutter has also led post-event field studies of the role of geographic information technologies in rescue and relief operations in (September 11th World Trade Center attack) and studies of evacuation behavior from Three Mile Island (1979), Hurricane Floyd (1999), and the Graniteville, SC train derailment and chlorine spill (2005). Most recently (2006) she has led a Hurricane Katrina post-event field team to examine the geographic extent of storm surge inundation along the Mississippi and its relationship to the social vulnerability of communities and how these affect long-term recovery in the region. She has provided expert testimony to Congress on hazards and vulnerability and was a member of the US Army Corps of Engineers IPET team evaluating the social impacts of the New Orleans and Southeast Louisiana Hurricane Protection System in response to Hurricane Katrina.

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Mega-City/Mega-Disaster Reduction: Reducing Social Vulnerability and Enhancing Disaster Resilience

More than 50% of the world's population is now urbanized. With the exponential growth in many of these urban areas, the number of megacities is increasing rapidly. In the largest megacities (those with more than 10 million inhabitants) nearly 75 percent of them are located near the sea, or a major river, or a delta, and more than half are located in active seismic zones. Estimates for 2015 suggest that more than 600 million people would live in the world's megacities, with the majority of the megacities located in developing countries. As urban growth expands the footprint of megacities, they are merging into mega-regions such as Hong Kong-Shenhzen-Guangzhou region, Nagoya-Osaka-Kyoto-Kobe; Rio de Janeiro-Sao Paulo; Megalopolis (Boston-Washington). Given the rapid rate of growth in the megacities and mega-regions, the disaster risks will increase in the next decade placing more people in harm's way with untold billions of dollars in infrastructure located in highly exposed areas. The complex and dynamic interaction between social, economic, political, and environmental processes insures that when a disaster strikes one of these megacities or mega-regions, there will be catastrophic losses of lives, property, and economic wealth resulting in major humanitarian crises.

There are two key principles in disaster risk reduction: 1) mainstreaming disaster prevention and mitigation into normal policies addressing social welfare, quality of life, infrastructure, and livelihoods; and 2) incorporating an all-hazards approach into planning and action. Disaster reduction is not only about reducing risks and exposure, but also includes systematic efforts to analyze and manage the causal factors of disasters by lessening societal vulnerability, improving land and environmental stewardship, improving preparedness, and enhancing societal resilience.

For many regions, the ability to limit exposure has already been achieved through building codes, land management, and structural mitigation, yet losses keep increasing. For disaster reduction to become more effective, megacities will need to address their societal vulnerability and the driving forces that produce it (rural to urban migration, livelihood pattern changes, wealth inequities). Many megacities have reached their tipping points, and are seriously compromised their ability to prepare for and respond to disasters, let alone recover from them.

To lay the groundwork for disaster risk reduction actions in megacities, we need to produce the following as a first step in an actionable agenda.

Spatial Assessments of Vulnerability. We need to understand the existing societal vulnerability and the inequalities in that vulnerability within the megacity or mega-region as baseline information. The impact of a disaster may be greater on the most vulnerable populations within the city, and these most vulnerable populations may reside in the areas with the highest exposure to natural hazards. Spatial assessments of vulnerability are now required in the U.S. as a part of the hazard mitigation planning at the state and local levels. These spatial assessments highlight the intersection of hazard zones, social vulnerability, and elements of the built environment (buildings and infrastructure) that interact to produce the overall vulnerability of the place. Systematic efforts to spatially assess the vulnerability (hazard, social, and built environment) of megacities at sub-city scales, provides the baseline information for policy decisions. A one-size fits all strategy for disaster risk reduction will be ineffective and not reduce the impacts of disasters for all sub-populations or areas. The mapped results are instructive for policy decisions in ascertaining mitigation alternatives, as in some instances it is not high levels of hazard exposure that are producing the disaster risk, but rather the social vulnerability of the people who live there. This necessitates very different intervention or mitigation strategies (e.g. poverty reduction), versus those that simply reducing exposure (e.g. elevating buildings).

Pre-Event Planning for Post-Disaster Recovery. A second area of need is the development of plans (pre-event) for how to move forward in post-disaster recovery. Such planning necessitates thinking about existing resilience (of buildings, of society, of the natural system), and ways that such resilience can be enhanced. It requires visioning and thinking about the driving factors of vulnerability and how to address them pre-and post-event, through such mechanisms as land use planning and control, resettlement, improved livelihood strategies, and so on. Such planning also needs to focus on community resilience, necessitating information on local governance structures, stakeholders and sectors knowledge, adequacy of basic services (transportation, water, sanitation, public health), social, financial, and natural capital, and institutionalization of range of social safety nets. These must be tailored to the conditions of the most vulnerable groups. The absence of adequate plans for enhancing existing resilience and moving towards a more disaster resilient and sustainable city (pre-event), will lead to reactive post-event actions that are bound to repeat past mistakes and failures and instead of reducing disaster risk, may ultimately increase it as megacities recover and reconstruction proceeds.

There are significant scientific challenges in the provision of actionable information for megacities as they struggle to reduce the impacts of disasters. The most significant challenge is to address spatial and temporal scale disconnects between science, planning, and decision making. Planning is done locally, sometimes regionally but within relatively short time horizons. Decision-making occur at all spatial scales, but is often temporally-limited based on the election cycles within countries, provinces, states, or cities. Research on disaster vulnerability and resilience requires long-term and sustained data collection activities to monitor changes in disaster risk and those factors influencing such change. The typically isolated one-time post-event case study is insufficient for advancing the science of these dynamic changes in vulnerability and resilience. To remedy this, a regional or international effort is required to establish observatory networks that will engage in long-term systematic data collection activities to monitor vulnerability and resilience, which in turn will permit improvements in analytical and modeling capabilities of disaster risk reduction and post-event recovery. The establishment of such regional observatories (such as the proposed RAVON in the U.S.) will not only enhance the cumulative knowledge base on hazards vulnerability and resilience, but it will help guide the implementation of effective disaster reduction measures.

References

Bohle, H-G., and K. Warner (eds.), 2008. Megacities: Resilience and Social Vulnerability. Bonn: UnU Institute for Environment and Human Security Source Report 10/2008. Available online:
http://www.ehs.unu.edu/file.php?id=462

Fuchs, R., 2009. Cities at Risk: developing adaptive capacity for climate change in Asia's coastal mega cities. Final Report for APN CAPaBLE Project, CBA2008-06NSY-Fuchs. Available online:
http://start.org/news/cities-at-risk-final-activity-report-apn.html

IRDR 2009. UNISDR Terminology on disaster risk reduction. http://www.unisdr.org/eng/library/lib-terminology-eng.htm

Kraas, F. et al., 2005. Megacities—our global urban future. Leiden, The Netherlands: Earth Sciences for Society Foundation, International Year for Planet Earth. http://iugs.org/uploads/images/PDF/07_megacities.pdf

Munich Re Group, 2004. Megacities-Megarisks: Trends and challenges for insurance and risk management. Munich: Munich Re Group. Available online: http://www.munichre.com/publications/302-04271_en.pdf

Peacock, W. G., H. Kunreuther, W. H. Hooke, S. L. Cutter, S. E. Chang, and P. R. Berke, 2008. Toward a resiliency and vulnerability observatory network: RAVON. Available online: http://www.nehrp.gov/pdf/RAVON.pdf

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Mega-City/Mega-Disaster Reduction: Persistent Challenges in Response and Recovery Management

Typical emergency response operating philosophies use a functionally-oriented command and control system to direct response and recovery following any sort of emergency event. In the U.S. this is systematized in national doctrine as the National Incident Management System (NIMS), which has at its core the Incident Command System (ICS). NIMS/ICS is an "all-hazards" approach intended to be employed to manage incidents of all types and of all sizes. This and other conceptually similar approaches around the world have a long and strong track record of success at enabling effective incident mitigation. Chief among the advantages of such systems is a commonly understood set of management conventions that allows numerous disparate agencies to work together seamlessly.

The way contemporary incident command and management systems are designed presumes that management requirements scale linearly from small, simple incidents to very large very complex incidents. The notion is that smaller incidents use a collapsed version of ICS, whereby only those functions warranted by the incident are staffed, and single individuals may assume several functional responsibilities. For larger, more complex incidents, or as a small incident grows larger and more complex, command and control structures expand to meet the demands of incident response. For very large incidents, multiple incident management teams each direct portions of the incident and are harmonized by superordinate command, control, and coordinating structures. Thus the management approach applied is essentially the same, regardless of the size and complexity of the incident.

In fact, however, though current incident management operating philosophies succeed well during moderately-sized or well-understood disaster events, they are inadequate in the face of very large, very complex incidents like Hurricane Katrina. Instead of scaling up to address these incidents, management systems persistently fail in substantial ways. Disaster after disaster, after action reports document management challenges that frustrate the effectiveness of response and recovery efforts. This means that a major gap in preparedness for Mega-City/Mega-Disasters (MCMDs) is an assured management infrastructure to guarantee effective command, control, coordination, and communication. In particular, there are three areas where the capability of current management systems is insufficient:

Leadership. MCMD scenarios are plagued by unclear, multiple, duplicative, isolated, and sometimes conflicting and uncooperative command structures. Large incidents demand that robust command and control structures emerge out of the initial chaos that inevitably ensues when disasters strike so that resources may be brought to bear quickly and effectively to save lives. Typically, though, these incidents also involve a multitude of agencies from many disciplines and jurisdictions—and even from several different nations—each of which directs its own resources. Since each entity has legitimate missions, responsibilities, and authorities, each uses its own command and control process to take charge, in a legitimate attempt to meet the needs the agency faces and solve the problems it is supposed to solve. Absent a pervasive approach to which all participants subscribe, however, confusion results. Note that the term “command and control,” does not assume structures that are unitary, rigid, or static. In fact, successful management requires collaboration, flexibility, and adaptability across multiple diverse actors. Likewise, management approaches need not be imposed, but may develop organically. Thus the practical challenge and research puzzle is how coherent joint management networks can emerge in MCMDs where there are a very large number of organizations involved who don’t know each other and don’t habitually work together.

Communications. Our systems of coordination are predicated on being able to garner and disseminate information to support collaborative decision-making and enable joint operations. A major challenge of large disasters is that they destroy our physical infrastructure, including our communications systems. Despite the known limitations and fragility of the existing infrastructure, we lack contingency plans for how to communicate when technology fails (or is destroyed). And beyond this, communications isn’t entirely (or even fundamentally) a technology problem. Communicating requires that people have useful, actionable information and that they are willing to share it with each other. Thus we face three research challenges: how to develop communications systems that will be available to us even during catastrophic events; how to create communications systems that work independent of technology; and how to generate the trusted relationships on which effective communications depend among people distributed across multiple, disparate, geographically distant organizations.

Logistics. Large-scale, long-duration incidents demand more resources–personnel, equipment, supplies, commodities, specialized capabilities–than any agency or government can maintain on hand, so these resources must be obtained rapidly when a disaster occurs. This makes resource identification, acquisition, management, and distribution a major function of incident management. Resources must be obtained "real-time," but normal management systems are too slow and are not designed to obtain large amounts of supplies rapidly and to distribute them directly to the places where they are needed, especially when transportation systems are disrupted. Private sector resource distribution systems, which make expert use of techniques like just-in-time resource delivery, are not designed around the episodic and uneven flows associated with disasters. Thus the research challenge is how to design systems that can predict the resource demands that will be levied by a disaster, identify resources to fill these demands in real time, and plan delivery systems that will work under the conditions created by the disaster.

Absent robust solutions to these fundamental challenges, response and recovery to MCMDs will be severely hindered. Viable solutions necessarily rest on technological innovation, particularly in the form of predictive models, management information systems, and decision support systems. That said, these technological solutions must give explicit consideration to the implications for people and the ways in which people interact in organizations and management structures which are designed around current tools and technologies. In short, solutions must be both usable and useful, and research approaches must therefore involve scientists, technologists, engineers, social scientists, and emergency response practitioners in close partnership with each other.

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Michael F. Goodchild is Professor of Geography at the University of California, Santa Barbara, and Director of spatial@ucsb. He received his BA degree from Cambridge University in Physics in 1965 and his PhD in Geography from McMaster University in 1969. After 19 years at the University of Western Ontario, he moved to Santa Barbara in 1988. He was Director of the National Center for Geographic Information and Analysis from 1991 to 1997. He was elected member of the National Academy of Sciences and Foreign Fellow of the Royal Society of Canada in 2002, and member of the American Academy of Arts and Sciences in 2006. He has received honorary doctorates from Laval University, Keele University, McMaster University, and Ryerson University. He has received the Canadian Association of Geographers Award for Scholarly Distinction, the Association of American Geographers award for Outstanding Scholarship, the Canadian Cartographic Association's Award of Distinction for Exceptional Contributions to Cartography, and the Educator of the Year Award from the University Consortium for Geographic Information Science. He has received Lifetime Achievement Awards from Environmental Systems Research Institute, Inc. and the Geospatial Information and Technology Association, and has been inducted into the GIS Hall of Fame of the Urban and Regional Information Systems Association. In 2007 he received the Prix Vautrin Lud. He was Editor of *Geographical Analysis* between 1987 and 1990 and Editor of the Methods, Models, and Geographic Information Sciences section of the *Annals of the Association of American Geographers* from 2000 to 2006. He serves on the editorial boards of ten other journals and book series. His published books include *Accuracy of Spatial Databases*; *Geographical Information Systems: Principles and Applications*; *Environmental Modeling with GIS*; *Scale in Remote Sensing and GIS*; *Interoperating Geographic Information Systems*; *Geographic Information Systems and Science*; *Uncertainty in Geographical Information*; *Foundations of Geographic Information Science*; *Spatially Integrated Social Science*; *GIS, Spatial Analysis, and Modeling*;

and *Geospatial Analysis: A Comprehensive Guide to Principles, Techniques and Software Tools*. In addition he is author of some 350 scientific papers. He was Chair of the National Research Council's Mapping Science Committee from 1997 to 1999, and currently chairs the Advisory Committee on Social, Behavioral, and Economic Sciences of the National Science Foundation. His current research interests center on geographic information science, spatial analysis, and uncertainty in geographic data.

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The Evolving Landscape of MCMD Information Flow

Geospatial information -- information about what is where -- plays an invaluable role in all aspects of emergency management, from preparedness and response to recovery and mitigation. Because of the costs associated with its production, geospatial information has traditionally been created and distributed by government agencies, with some assistance from the private sector, in a top-down, radial pattern. In recent years new technologies, including GPS and GIS, have dramatically reduced the cost of acquiring and disseminating geospatial information, effectively to zero, and have also dramatically reduced the time delays involved. The term *neogeography* describes a world in which there is no longer any effective distinction between amateur and expert, since the skills and tools needed to produce geospatial information are in effect available to all.

Nowhere are these changes more apparent than in the domain of emergency management. While citizens used to rely on official sources for current information on the progress of disasters, evacuation orders, and the locations of shelters and other facilities, today much of this information is being generated and disseminated by citizens. The general public provides a dense network of observers who are typically enabled by devices that range from cellphones to computers, and connected through broadband networks. By contrast government agencies cannot field large numbers of observers, and must rely instead on remote sensing and other technologies with fine spatial resolution -- but such technologies are impacted by smoke, cloud, infrequent overpasses, and many other constraints.

Moreover official information must be verified before it can be disseminated, a process that inevitably takes time in what are often time-critical situations. Numerous examples of the transition from agency-dominated to citizen-dominated information flow can be found, ranging from recent wildfire emergencies in Santa Barbara to the base mapping that has supported the Port-au-Prince relief effort.

This new landscape raises numerous issues, perhaps the most important being accuracy. Rather than guarantee accuracy, crowd-sourced data invites the user to balance timeliness with accuracy, accepting risky data that is available now rather than reliable data that may not be available for some time. False positives are more likely than false negatives, but are more acceptable because the associated risks are less severe. The geospatial nature of the information also invites several specific strategies for addressing accuracy, including the importance of context, the difficulty of faking geospatial information, and the role of the crowd in driving toward consensus.

A variety of literatures are relevant, including the literature on trust, on uncertainty in geographic information, and on spatial data infrastructures. Systematic research is just beginning, and is starting to yield some important insights.

Tswen-Juh Gu

Capt. Gu graduated from the Chinese Navel Academy with a Bachelor of Science degree in August 1976. During 28 years served in the navy, he finished four Commanding Officer's tours of ROCS Sho Shan (PF-837), ROCS Jeng Yang (DDG-928), ROCS Tze Yi (PFG-1107) and ROCS Cheng Ho (PFG-1103) in 1991, 1995-97 respectively. When the Taiwan Straits missile crisis occurred in 1996, he lead his ship forward deployed to Pescadores Isles as the front line response force.

During the 1999 Chi-Chi earthquake period, he was tasked as the Chief Coordinator by the Ministry of National Defense for US Rescue Team. He was also in charge of Port Security Assessment Program with the US Defense Threat Reduction Agency in 2002 and ASW Assessment Program in 2003 collaborating with the US team.

Capt. Gu is currently working toward a Ph.D. degree in the School of Management, National Taiwan University of Science and Technology. His research interests include modeling & simulation, C4ISR and Service-Oriented Architecture and emergency management.

He has been a Certified Emergency Manager (CEM®) since February 2010. He currently serves as the Taiwan Representative of International Associations of Emergency Managers (IAEM) voluntarily to promote and to advance the emergency management profession.

The education background and experience fields are introduced as follows:

Education & Academic Background:

B.S. Chinese Naval Academy 1976 class

M.S. in Operations Research, Rensselaer Polytechnic Institute 1983 class, Troy, NY

US Naval War College 1994 class, Newport, RI

National Security Study, Israel Galilee College 2002 class

Asia-Pacific Center for Security Study, USPACOM 2003-1 class

Ph.D. Candidate in Management Science, National Taiwan University of Science and Technology, 2004

Subject matter expert:

Enterprise Architecture, Web Services Technology, System Simulation, Defense Analysis, Space Technology, C4ISR, War Gaming, Emergency Management

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A Net-Centric View on Emergency Information Management in Taiwan

Problem Statement: The emergency management (EM) system failed to respond in a timely fashion after the disaster happened in the early morning of Aug. 9th in Southern part of Taiwan. The administration was criticized by the public because the response was both late and uncoordinated. In general, there were many drawbacks in Morakot's disaster operations: media communication, philosophy of command, leadership, coordination, and IT integration etc.. This paper is focusing on information management issues and trying to analyze what causes the information system to have such negative outcomes and unpopular results.

Objectives: Using a systematic approach, the emergency information system needs to be restructured or modified to expedite the response in facing all hazards.

Analysis of the problem: Carefully reviewing the historical records, the problem with the process of handling Typhoon Morakot is a lack of timely and accurate information from the scene. The information flow is more top-down, one-way oriented or information compartmented.

Following the Disaster Prevention and Protection Act, the Emergency Management system was organized into three levels: central, city or county and township. Only the first two levels have their own Emergency Operations Center (EOC). The interoperability problems which exist also blocked the information sharing among all operations centers and military assets. The vertical administrative structure and command authorities caused a lack of information flow which is limited by having a stove-pipe system or even worse in place. Some data integration was only done through voice connections and redundant typing. There were no single integrated common operational picture (COP), Web-based common alert protocol (CAP) and standard EDXL to facilitate communication.

Solutions and Conclusion: The concept of Net-Centric Operations has the potential to increase response capabilities by orders of magnitude. It is based on a robustly networked response force and information sharing. Applying Commercial-Off-the-Shelf (COTS) information technology, e.g., Service-Oriented Architecture and enterprise service bus, might be one of solutions to break through the information silos in such a heterogeneous environment. Another critical issue is that CEOC need establish a Joint Information Center (JIC) to correlate, filter, fuse and correct the information from Call Centers, Web Center and Media Center.

The disasters will happen someday. We need an integrated emergency management system to meet the challenges and manage incidents which arise in the future.

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Michael (Mike) Hall is the Team Leader for the National Incident Management Assistance Team-West (IMAT), a Senior Executive Service (SES) position. As an FCO, Mr. Hall has lead Federal response and recovery efforts for FEMA during more than a dozen Presidential Disaster Declarations including assisting USAID following this year's Earth Quake in Haiti, the 2009 Floods in North Dakota, Hurricanes Gustav and Ike in Louisiana in 2008, the 2007 California Wildfires, Mt. Lemon Fires in Arizona, Kansas Tornadoes, Ice Storm in Ohio, Tropical Storm Henri and Hurricanes Isabel, Ivan. He is credentialed as a Type 1 FCO.

Previously, Mr. Hall spent more than 26 years in the U.S. Coast Guard, where he retired as a Captain. In 1999 he led the emergency response to the Motor Vessel New Carissa shipwreck and oil spill. He also served as the Assistant Chief of Operations for the Exxon Valdez oil spill.

Prior to joining the Coast Guard, Mr. Hall was a Washington State Trooper for six years.

He holds a Master's Degree in National Security and Strategic Studies from the United States Naval War College and has attended Harvard University's John F. Kennedy School of Government.

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Mega-City/Mega-Disaster Reduction

I would suggest that Mega-city/Mega-Disasters will continue to happen around the world....it is not *IF* but rather *WHEN*! Given that as a premise, the real question then is how do we prepare for, respond to, recover from and mitigate Mega-Disaster?

I believe that if we do not complete the full-circle at the individual, local, state and national levels then the victims of these mega-disasters will not become survivors but rather they will end up being victimized twice....once by the disaster and once by a bureaucracy that failed at all levels. In the background materials there were some excellent examples of where Mega-city/Mega-disaster responses were impeded by governments, agencies and populations being less than fully prepared for the "next one". More recently this was once again demonstrated in Haiti where simple communication, education, planning, coordination and mitigation would have lessened not only the impact of this earthquake but provided a much more effective response and recovery effort. That did not happen in Haiti and in my view the victims have been victimized twice.

The question remains, what can we do as we focus on Mega-city/Mega-Disasters? The answers start with each individual understanding that they are part of the solution, that they are a resource and not a liability, that they must be prepared, they must have a plan...planning is the key and not necessarily the plan itself; governments must expand their team to include the private sector, non-governmental organizations (NGOs) and local citizens, they must develop and enforce stricter construction codes and they must pre-identify highly vulnerable buildings in disaster prone areas (whether it be from flooding, fires, earthquakes, tornadoes, hurricanes, typhoons or any other natural disaster). We at all levels of government along with the private sector and the local citizens must work in a coordinated and collaborative manner. Each of us understands that all disasters are local but Mega-city/Mega-Disasters require a Mega-Response working with everyone working in a coordinated and systematic way. The Incident Command System (ICS), the Unified Coordination Group (UCG) and the Area Command (AC), coupled together with a deliberate planning system and an executable Incident Action Plan (IAP), are the cornerstones of success and will turn victims into survivors.

Our challenge is to build these systems at all levels of government and across all societies as natural disaster know no boundaries; Mega-Disasters will continue to happen and our challenge is to mitigate their impacts through workshops like this one.

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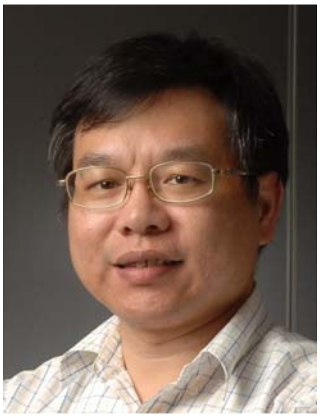

Chingteng Hsiao is currently a research engineer in the Research Center for Information Technology Innovation (CITI) at Academia Sinica, Taiwan. Dr. Hsiao earned his Ph.D. degree in aerospace engineering from University of California, Los Angeles in 1993. In 1998, he co-founded Yam Digital Technology, an internet start-up that provides information and community services and was recognized as the first generation Internet entrepreneur in Taiwan. He then continuously served the internet industry for nearly 10 years before he joined Academia Sinica in 2007. Dr. Hsiao research interests include social networking services, data portability, user-centric identity, linked data and crowdsourcing.

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Driving the Power of the Crowd for the Emergency Response

Sahana, an open-sourced emergency management system, was first introduced into Taiwan right after last year's flood caused by Morakot typhoon. Ideas about adopting the system in Taiwan were exchanged over Twitter and wikis and a basic localization was done by volunteers in couples of days though the system was not ready to go public in the end. Sahana and other online systems like Ushahidi and OpenStreetMap, again played crucial roles in the response and recovery of Haiti earthquake and Chile earthquake early this year. These systems either empower individual participants to contribute in a bottom-up manner or help humanitarian groups to coordinate their efforts during the disaster response. Information technology indeed drives the power of the crowd and saves lives. Here in Taiwan, the Sahana response team was formed under the support of CITI, Academia Sinica last year. A fully localized version that meets the requirements of local humanitarian organization is in progress and the deployment of the system is expected on early July.

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Ching-Yuang Huang is a Chair Professor at the Department of Atmospheric Sciences, National Central University in Taiwan, and the Director of GPS Scientific Application Research Center in Taiwan. He held a B.S. and a M.A. in Meteorology from the Department of Atmospheric Sciences, National Taiwan University in Taiwan, and a Ph.D. at the Department of Marine, Earth and Atmospheric Sciences, North Carolina State University in U.S.A. in 1990. He received "the Outstanding Research Award in Meteorology" in 1997 from the National Science Council of Taiwan. His major interests focus on typhoon dynamics and numerical weather prediction with advanced data assimilation of a variety of measurements, in particular, the FORMOSAT-3/COSMIC GPS radio occultation (RO) observations. He has published many SCI journal papers mostly regarding mesoscale and typhoon dynamics and modeling and latest the impacts of GPS RO data on numerical predictions of regional weathers including typhoons impinging Taiwan.

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Missions and Status of Taiwan Typhoon and Flood Research Institute

The Taiwan Typhoon and Flood Research Institute (TTFRI) was first founded as a Preparatory Office under the National Applied Research Laboratories (NARL) in January, 2007. Its missions include identifying the requirements and gaps for disaster relief and mitigation agencies, integrating domestic meteorological and hydrological science research and thus developing the core technologies for an integrated platform.

In order to achieve these goals towards synergy, TTFRI endeavors in building a comprehensive research archive by integrating existing databases and provide easy access for basic research. We also work closely with universities in initiating interdisciplinary laboratories and collaborative projects, assisting these multidisciplinary teams in typhoon and flood observation fieldwork, data collection and analyses.

TTFRI has had a vision for synergy since the beginning as a Preparatory Office, and is keen on moving towards to realizing its missions while preparing for its official launch in the near future, that is to develop core technologies in numerical weather modeling, quantitative precipitation estimate/forecast (QPE/QPF) tecniques, hydrology modeling and observation capability. We also aim to foster the manpower for advanced typhoon and flood research in Taiwan, boosting the quality and quantity of our research development and accentuating Taiwan’s regional R&D capacity for a world-class typhoon and flood research institute.

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Norden Huang is the TSMC Chair Professor and the Director of the Research Center for Adaptive Data Analysis at the National Central University, Chungli, Taiwan, ROC. He held a Bachelor Degree (1960) in Civil Engineering from the National Taiwan University, and a Doctoral Degree (1967) in Fluid Mechanics and Mathematics from the Johns Hopkins University. He was a senior Fellow and the Chief Scientist for Oceanography at NASA Goddard Space Flight Center till September 2006, before joining NCU. His recent research has concentrated in the development of a new adaptive data analysis method, the Hilbert Huang Transform (HHT), designed specifically to analyze nonstationary and nonlinear time series. For the invention of HHT, he was awarded the 1998 NASA Special Space Act Award with the citation, '[Dr. Huang's new method] is one of the most important discoveries in the field of applied mathematics in NASA history.' This invention has won him the 1999 Federal Government Technical Leadership Award; the 2001 R&D 100 Award; NASA Inventor of the Year 2003 and the 2006 Service to America Medal for Science and Environment. Based on his contribution in the field of nonstationary and nonlinear data analysis, he was elected as a member of the National Academy of Engineering (US), 2000; an Academician to the Academia Sinica (Taiwan), 2004; a Foreign Member of the Chinese Academy of Engineering (PRC), 2007; and a Fellow, SIAM, 2009.

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A Plea for Adequate Data Analysis Methods

No matter what we want to do related to MCMD, we need good data and, more importantly, adequate data analysis methods. Traditionally, data analysis methods are based on *a priori* basis, which forces us to make the critical linear and stationary assumption even before we look at any data. But real natural phenomena or engineering performance assessment data are seldom linear or stationary. As a result, data analysis had been relegated, to a large degree, to 'data processing', where data are routinely put through certain rigid algorithms to extract some mathematically meaningful parameters. As observed by Einstein: "*As far as the laws of mathematics refer to reality, they are not certain; and as far as they are certain, they do not refer to reality*." A more appropriate approach to represent nonlinear and nonstationary data is to have an adaptive basis. A new adaptive data analysis is introduced here. Classical nonlinear system models are used to illustrate the roles played by the nonlinear and nonstationary effects in the energy-frequency-time distribution. Some examples will be presented to illustrate the prowess of the new adaptive data analysis methods that would include bridge and other structure health monitoring studies.

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J.C. Huang is a senior researcher and executive assistant to the Director General at Energy and Environment Laboratories (EEL), Industrial Technology Research Institute (ITRI), Chutung Township, HsinChu County, Taiwan. Before joining EEL/ITRI, he worked at Taipei with Science and Technology Advisory Group (STAG) of the Executive Yuan for 20 years. His professional interests cover civil and environmental engineering, climate change mitigation and adaptation, earth sciences, energy and resources, as well as technology management. He was trained in geosciences (geophysics), fluid mechanics and groundwater flow computer simulation, and technology management.

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Tracy Kijewski-Correa is Associate Professor and Associate Chair of the Department of Civil Engineering and Geological Sciences at the University of Notre Dame and performs research largely focused upon improved understanding of structural response under dynamic loads. These efforts include an NSF-funded, full-scale monitoring program for signature buildings in three countries around the globe. Other activities include research in cyber-physical systems and embedded sensing, in collaboration with a multi-disciplinary, college-wide research team focused on wireless sensor networks for detection of damage in civil infrastructure and terrorist activities in major cities. In addition, Dr. Kijewski-Correa is a PI on two NSF-funded projects leveraging cyber-infrastructure to mitigate wind hazards on structures and to create new paradigms for open sourcing the design of civil infrastructure. Recently, these efforts have been extended by Notre Dame's SAPC Program to include the seeding of CYBER-EYE: A Cyber-Collaboratory for National Risk Modeling and Assessment to Mitigate the Impacts of Hurricanes in a Changing Climate. Dr. Kijewski-Correa was also involved in post-disaster reconnaissance and sustainable redevelopment after the 2004 Boxing Day Tsunami in Southeast Asia and the 2010 Haiti Earthquake. She will now lead the infrastructure team in Notre Dame's "Committed To Haiti" redevelopment program.

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Leveraging Cyberinfrastructure to Achieve Hazard Resilient and Sustainable Communities: Lessons Learned in the Technology Adoption Life Cycle

In our increasingly interconnected society, the impacts of natural disasters can ripple regionally and even globally. Sadly, our response to date has failed to leverage the intellectual and computational resources being developed globally to decrease these hazards' threats to life, to infrastructure, to ecosystems, and to local and global economies. This has largely stemmed from a deeply engrained habit of executing research using limited local resources scattered physically throughout university, government, and private research laboratories as well as industry and trade organizations. Additionally, this traditional approach to research and even education fails to acknowledge the intersection of this work with economics, public policy and social science.

Recently the United Nations has called for "e*nhanced k*nowledge/technology transfer through cyberinfrastructure," a sentiment shared by the US National Science Foundation in its prototyping of several engineering virtual organizations (EVOs) in an number of disciplines, including civil engineering. These efforts have sought to incentivize sharing of resources in the form of databases, computational and experimental tools, and full-scale data to usher in a 21st Century Research Paradigm capable of truly responding to the threats of natural hazards. Further, these efforts recognize that the nature of many these hazards as well as the complexity of the societal systems they impact requires a dramatic expansion of the intellectual and cyber-infrastructure supporting research at the intersection of numerous disciplines. Not only can such EVOs create an accessible venue where diverse stakeholders can be engaged to realize an integrated computational platform far more powerful than the sum of its parts, but they facilitate the evolution of social networks that can catalyze new interdisciplinary, international collaborations.

However, though well-intentioned, seeding EVOs with participants and resources and then providing incentivization and governance to sustain and grow these EVOs has proven challenging. Therefore, while scalable cyberinfrastructure and global virtual collaboratories will undoubtedly play a crucial role in the enhancing the hazard-resilience of Mega-cities, these efforts will have limited success without appropriate consideration of the psychology of participants/collaborators and the needs and technology readiness of end users/stakeholders, as well as the natural reluctance on the part of many researchers to freely share proprietary data sets and resources. Therefore, any viable effort must also understand how the *Technology Adoption Life Cycle* enables discontinuous innovations to be realized and must be informed by social science to identify appropriate niche groups to seed the virtual collaboratory and appropriate education and outreach mechanisms to foster its growth.

Our experiences with the founding of an EVO dedicated to mitigating the hazards associated with wind-driven events (VORTEX-Winds), the foundation of an integrated cyber platform for risk modeling and assessment for hurricanes (CYBER-EYE), and the launch of a new Cyber-Enabled Discovery and Innovation Project on open-sourced approaches to the design of Civil Infrastructure using Citizen Engineers will be shared at this workshop to underscore both the power of cyber-enabled collaboration, as well as the barriers that arise both in both achieving scalable, secure and trustworthy work flows while the traversing technology adoption chasms presented by both collaborators and end users.

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George C. Lee is a SUNY Distinguished Professor in the Department of Civil, Structural and Environmental Engineering. Previously, he had served as Chair of the Department of Civil Engineering (1974-77) and Dean of the School of Engineering and Applied Sciences (1978-95) at UB. Since 1995, Dr. Lee is Samuel P. Capen Professor of Engineering. Between 1992 and 2003 he served as Director of the Multidisciplinary Center for Earthquake Engineering Research (MCEER). He earned both his Ph.D. and M.S. degrees at Lehigh University, and his undergraduate degree from the National Taiwan University. His research expertise is in the areas of structural engineering and mechanics, with emphasis in steel structures and earthquake engineering. In his earlier career, he also made contributions in cold regions structural engineering and in biomechanics and living systems. In recent years he contributed extensively in seismic design of structures with added response modification and isolation systems, decision-support systems for managing utility systems for critical facilities, and seismic design of segmental piers for accelerated bridge construction. During the past five years, he devoted a major effort to establish design principles and guidelines against multiple extreme hazard events for bridges and infrastructure systems.

Dr. Lee has held leadership positions in numerous professional organizations in which he is a member including the American Society of Civil Engineers, and has served as the editor or as a member of editorial boards of several ASCE and international journals. At present, he is the editor-in-chief (US) of *Journal of Earthquake Engineering and Earthquake Vibration.* He is the recipient of numerous awards and citations including the superior accomplishment award from NSF, and the Newmark Medal of the ASCE. In 2006, he received a Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring.

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US-Taiwan Workshop on Mega-City/Mega-Disaster (MCMD)

There is definitely a need to formulate strategies for densely populated communities to become more mega-disaster resilient. Major natural and manmade disasters in recent years throughout the world have elevated the urgency to systematically examine the complex, interlocking mitigation and response issues, to establish and prioritize research foci and to identify the weak links of the organizational infrastructure responsible for safeguarding these disaster vulnerable mega-city and/or densely populated communities.

In recent years, many conferences and workshops have been organized on a variety of relevant topics such as understanding and forecasting extreme events; loss estimation methodologies for the physical and social infrastructure systems due to individual hazards; hazard mitigation technologies for constructed facilities; disaster preparedness and emergency management, etc. The outcome of these gatherings has been very limited from the MCMD perspective. Because the scale, nature, scope and complexity of the MCMD problem are also at a “mega-level,” which were never addressed systematically by the funding organizations nor the academic research community. There are too many unknowns at all levels and involve too many disciplines.

It is highly desirable that this US-Taiwan Workshop gives emphasis to establish an overall plan involving a series of future MCMD workshops over the next few years, and a roadmap to systematically identify and prioritize the future research agenda. Important issues are addressed in several future workshops each by an expert group. For example, this workshop should identify the extreme events to be considered, but the state-of-the-art on methods to forecast the frequency of occurrence of the selected extreme hazards and their intensity or other disaster-specific topics would be addressed by appropriate expert group in future special workshops. This workshop should not talk about a new sensor, a control system or a nonlinear structural analysis method.

Based on my very limited experience from working on multi-extreme hazard design of bridges, I would say that the emphasis of this first workshop should concentrate on developing only one or two themes at most (the last two). In my opinion, the most important theme for MCMD now is disaster preparedness and emergency management to minimize casualties. It is not too closely related to the type of disaster, so it does not require the integration of experts from different scientific disciplines. The next most urgent theme for MCMD is a vulnerability assessment method of the physical and organizational infrastructure. This is very tricky because community vulnerability is a dynamic process. Both these themes should only include necessary and relevant technologies, excluding those applicable at the lower systems levels (e.g. structural control).

Two years ago in planning of a post-mega earthquake workshop, I proposed a new focus for discussion to establish several levels of minimal casualties to aid in the development of policies and planning decisions for dense urban communities. It was rejected by engineering researchers, as they typically are conditioned to use no structural collapse as the bottom line. However, in preparing for a potential mega-disaster, a mega-city has to be realistic and willing to accept the possible outcome of a limited number of casualties when developing mitigation policies and response strategies. I suggest that this first MCMD workshop address this issue as well.

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Debris Flow Hazard Assessments with Numerical Modeling

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Debris flow disasters are usually accompanied by serious loss of lives and properties. However, debris flows are also part of earth's natural phenomenon, what is the reasonable budget to be spent on mitigation measures becomes an important issue for the budget allocation processes. This paper utilizes economic concepts to propose a reasonable estimation of the hazard damage and the cost of proposed mitigation measures. The proposed method is composed of four steps, namely, delineating the area of the disaster with different return periods, itemizing the land use within those area, calculating the hazard lose using official values and computing the expected probable maximum loss with a probability distribution. The comparison between the assessment of hazard and the economic gains of any proposed mitigation measures can be used as a reference for future decision making process.

Keywords: Debris flow, Hazard assessment, Risk analysis, Numerical Simulation, GIS, econometric model.

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Global data (GPCP) covering the period 1979-2007 are examined for changes of precipitation extremes as a function of global mean temperature by using a new method which focuses on interannual differences rather than time series. This work finds that globally the very heavy precipitation (top 10% bin of precipitation intensity) increases by about 95% for each degree Kelvin (K) increase in global mean temperature, while 30%-60% bins decrease by about 20% K^{-1}. The global average precipitation intensity increases by about 23% K^{-1}, substantially greater than the increase of about 7% K^{-1} in atmospheric water-holding capacity estimated by the Clausius-Clapeyron equation. The large increase of precipitation intensity is qualitatively consistent with the hypothesis that the precipitation intensity should increase more than 7% K^{-1} because of the positive feedback from additional latent heat released. However an ensemble of 17 latest generation climate models estimates an increase of only about 2% K^{-1} in precipitation intensity, about one order of magnitude smaller than our value, suggesting that the risk of extreme precipitation events due to global warming is severely underestimated by the IPCC2007 climate models.

The increase in precipitation intensity is found about twice a large at low latitudes (30S – 30N) than higher latitudes. For example, the top 10% bin of precipitation intensity at low latitudes increases by about 130%K^{-1}, but only about 70% K^{-1} at latitudes above 30 degrees. Increases in heavy precipitation can lead to more floods. On the other hand, chronic decreases of moderate precipitation pose a serious threat to droughts because moderate precipitation is a critical source of water for soil moisture. Given the fact that there has been about 0.8 K global temperature increase since the industrial revolution, our results imply that floods caused by the top 10% heavy precipitation have increased by about 100% at low latitudes, and similar increases have occurred in the risk of droughts due to the decrease of moderate precipitation. Thus low latitude nations are suffering and will continue to suffer the bulk of increasing risk of floods, mudslides and droughts due to global warming. Since mitigation of the greenhouse warming by reducing CO_2 emissions will take decades to be effective (because the CO_2 residence time in the atmosphere is about 80 years), it is imperative that adaptation strategies such as flood control, water resource policy and alternative land use plans are implemented quickly.

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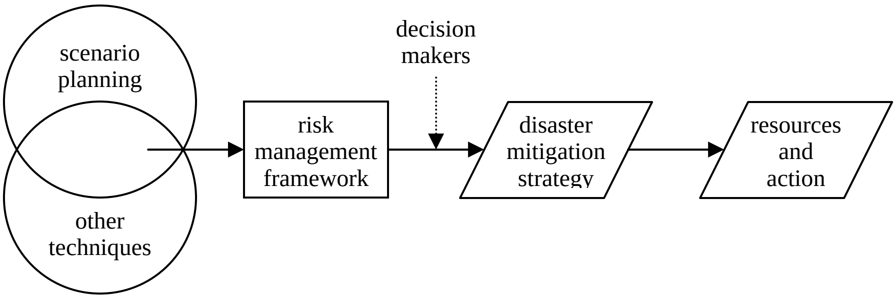
Application of Scenario Planning to Risk Management: Building the Strategic View of Disaster Mitigation

More and more owners and operators of infrastructures are facing the challenges and uncertainty of rapid change due to fast-moving political, environmental, social and technological developments. Risk management based on historical precedent and performance is necessary, but not sufficient. The concept of how we adequately "manage" the risk of infrastructures in this endlessly changing has evolved from techniques application to strategy flexibility.

Risk is the possibility of meeting danger or suffering harm and loss in the future. Risk management is the method and practice of identification, analysis, assessment, monitoring, communication and treatment of threats and weakness. Its purpose is to establish and maintain the security context for infrastructure so that future danger, harm and loss could be transferred, mitigated or avoided. How well the purpose is approached and realized is a matter of the quality of the disaster mitigation strategy and its associated resources and action. One way to better the strategy quality is to incorporate scenario planning into the domain of risk management. Scenario planning is a disciplined method for imaging possible futures in which organizational decisions may be played out (Paul Shoemaker 1995). It is a part of strategic planning which relates to the tools and technologies for managing the uncertainties of the future (Gill Ringland 1998). A feature of scenario planning is that it provides a conversational and consensus process among stakeholders who shape the future and/or are affected by the future.



A carefully orchestrated risk management framework, derived from scenario planning and other techniques, to be developed is suggested. Within that framework, quantitative indicators of risks will be categorized, calculated and balanced, as the future unfold, to reflect and response to the diverse aspects of political, environmental, social and technological change. The strategy of disaster mitigation could be therefore developed and executed as well as the resources and action of disaster mitigation would be better allocated, utilized and optimized.

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Coordination and Operation of Post-even Management Plans by Harmonized and Standardized Measures

The theme of disaster recovery is to keep the ability of government, business and civil society to function at a certain service level. Its goal is to uphold democratic governance, to sustain critical infrastructure, and to maintain basic societal values. The very purpose and benefits of harmonized and standardized measures for recovery coordination and operation are to shorten the period of disruption and reducing the impact of incident so as to minimize the socio-economic impact and loss of natural hazards. Additionally, harmonized and standardized measures could be used by governments as technical support and communication tools to help implement regulation and policy in crises.

It is clear that cooperation between public and private organizations in matters of developing and practicing harmonized and standardized measures to form a collection of managerial and technical rules within a consensual framework is advantageous since the resulting synergy can integrate various recovery resources and streamline community-wide and large-scale discovery procedures. These “codified” recovery knowledge, practices and lessons can lead to lower coordination and operation costs in the course of hazard recovery as a whole, as well as to provide the society savings.

The development of ISO 22300 series, encapsulating glossary, specification for continuity management systems, command, control, coordination and cooperation, information and data requirements for command and control, warning procedures, public-private partnerships, guide to exercising and testing, and guidelines for the preparation of continuity management systems, provides good reference documents to build a common approach for disaster recovery. ISO 22300 series and similar efforts serve as a systematic structure; however, a suite of practicable, interoperable and flexible measures (e.g. standards for interim housing, clean water and waste treatment) need to flesh out. Based on ISO 22300 series, it is suggested and encouraged that the collaboration between interested bodies to develop, agree on and implement harmonized and standardized measures for disaster recovery is planned and realized. Specifically, a physical and/or virtual platform for reaching consensus on these measures and a lessons-learnt repository of practices are recommended.

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Technologies Required for the Mitigation and Management of Mega-Disasters

Reducing vulnerability to natural hazards is a critical concern for natural hazard prone area. However, hazards vary by location, and society has scarce resources to devote to mitigation. Decision makers need methods for integrating realistic predictions of disaster effects with information about community assets and the costs of possible mitigation options so that these options can be effectively prioritized. For example, information on the likely locations and extent of potential ground failures from a specific earthquake source is required for prioritizing earthquake mitigation efforts before an earthquake occurs. Hazard management framework contains three major issues: Hazard risk assessment (science & engineering knowledge), emergency management (planning and mitigation tool), and emergency services (lifelines and social services). To provide community resilience to natural physical hazards research agencies, government, and community must collaborate and communicate to each other under this hazard management framework. Development of knowledge-based emergency and risk management support system can provide excellent support system for hazard management. Missions of emergency management in national level covers: a) promote sustainable management of hazards, b) enable communities to achieve acceptable levels of risk, c) require local authorities to coordinate EM planning and activities through regional Groups, d) provide for integration of national and local emergency management planning, e) encourage coordination across agencies, f) Defines roles and responsibilities of national agencies and international assistance. Effective emergency hazard management included emergency preparedness, response, and recovery result from the coordinated and collaborative efforts of multiple organizations, both governmental and commercial. These organizations must not only coordinate their preparations for and initial response to all types of emergencies, but must remain coordinated and collaborative in highly dynamic and volatile situations.

One of the important elements for reducing the MC/MD hazard is to develop a close relationship among local government, emergency services, welfare sector, community and lifelines. The local government needs to provide commitment to work together, to develop and coordinate planning and activities, and do the work on readiness, response and recovery. The emergency services need to plan and exercise jointly with emergency management group members and carry out emergency management group plan functions. The welfare sector and community need to plan and exercise jointly, and service meet emergency. Due to the change of infrastructure and the environmental situation, enhancement of both typhoon and earthquake disaster emergency response capabilities must be conducted, such as to assemble hazard warning information from all related agencies and to provide all the assessment information sources and coordination among all related agencies (government and private) to assemble hazard information for hazard management.

Finally, to develop MC/MD hazard mitigation the following future works need to be strengthened

A. Enhancement database and decision-support system

Many databases for disaster reduction have been built by government units, but most of them are scattered in different agencies, and difficult to integrate. Therefore, they can only provide limited information for decision-support systems. To establish information system for disaster decision-support system, special attention will be given to the following points:

- Standardizing classification, format, quality of data and procedure for data updating,
- Adopting an open type of GIS technology to integrate the spatial geographical information scattered in different units and NGOs,
- Establishing a common platform for the disaster reduction database,

B. Application of remote sensing technology

Remote sensing technology can provide effectively observed information for different types of disaster. They can be used to monitor field situation of disaster and thereby to assess losses in a large area. The effort to promote application of remote sensing will be concentrated on the following:

- Upgrading capability for disaster monitoring and investigation by well-developed high technology, such as airborne radar,

- Establishing a multi-functional telemetric data integration center for integration of data from different time and sources,
- Developing and implementing a comprehensive land use monitoring program,

C. Establish Sustainable land use management

In recent years, the risk of large-area landslide, debris flow and flood disasters have drastically increased. The fundamental way to reduce the risk of these disasters is to avoid improper land exploitation. The development of technology for land use management will be focused on the following:

- Establishing a disaster risk assessment system for land use planning,
- Intensifying research on land use development and ecological engineering related to disaster reduction,
- Integrating effectively the land use management mechanism with the disaster reduction operations system,

D. Establish inter-ministerial collaboration mechanism

Because the subject areas for research and development in disaster reduction technology are of highly interdisciplinary and inter-ministerial natural, it is learned that consolidated planning, coordination and management are critically important. Methodology and system development for mega-city and mega-disaster hazard mitigation need an integration of a lot of assessment tools and policies.

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Technology of Multi-Functional Infrastructural Systems for Earthquake Disaster Mitigation

Motivation:

- Because the intensity and frequency contents of an earthquake are generally unpredictable, conventional infrastructure systems, which have constant design parameters, usually do perform satisfactorily in an earthquake that is considerably different from the design earthquake.

- It will be uneconomical to design a conventional structural system that is able to sustain a wide range of earthquakes.

- Therefore, future infrastructural systems should be more adaptive to seismic loadings, and be designed with multi-functional properties for different types of earthquakes.

Disadvantages of conventional infrastructural systems:

- A structural system with ductility design may be considered as one kind of multi-functional infrastructural systems. This type of structures uses its elastic property (stiffness) to resist a medium earthquake, and uses its inelastic property (ductility) to resist a strong earthquake. The structural ductility is provided by the structural members or joints.

- Disadvantages: (1) In a strong earthquake, the primary structural components will be severely damaged, so the structure becomes un-repairable. The resiliency of these infrastructures is costly and time-consuming. (2) Because the ductility is provided by the structural elements and joints, due to structural complexity and on-site construction conditions, it is usually very difficult to construct a structure whose inelastic behavior exactly follows the design theory.

Multi-functional infrastructural systems (MFIS):

- A MFIS is able to ensure: comfortablity in a minor earthquake; functionality in a strong earthquake; live-safety in a strong earthquake; being repairable after a major earthquake. A MFIS can be realized by adding multi-functional devices in an infrastructural system.

- The features of a multi-functional device: (1) it has different mechanical properties in different types of earthquakes. (2) It is usually nonlinear. Its nonlinear or inelastic mechanical properties designed by the engineers should be easily fabricated. (4) It can be sacrificed in a severe earthquake to protect the infrastructure system itself. If damaged, the device can be easily replaced to expedite the infrastructure resiliency.

Example of multi-functional devices: seismic isolators with variable properties. The design goal of this kind of isolators is to reduce the transmitted ground acceleration to a minimum for earthquakes within the design range, but to suppress the isolator displacement to ensure the safety of the system in a severe earthquake that may produce an excessive isolator displacement.

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Opportunities for Sensing and Actuation Technologies for the Mitigation of Mega-Disasters

Recent natural disasters including the Indian Ocean Tsunami (2004), Hurricane Katrina (2005), Sichuan Earthquake (2008) and Typhoon Morakot (2009) have all elevated the public's awareness in the vulnerability of large urban areas (*i.e.*, megacities) to natural hazards. The degree of physical destruction, the spatial impact of the events, and the lingering social and economic issues that result has led many to term theses events as "mega-disasters". Three factors make the occurrence of mega-disasters more likely in the future: 1) population growth in already dense urban centers; 2) poor construction quality of infrastructure systems in developing nations; and 3) deterioration of aging infrastructure in developed nations. Clearly, multidisciplinary solutions are direly needed to mitigate the effects of mega-disasters.

The safety of the civil infrastructure systems that society depends upon for its prosperity can be dramatically enhanced through the ubiquitous adoption of sensing and actuation technologies. The recent technological advancements in the information technology domain have resulted in many new sensing modalities that can be used to address the risk posed by natural hazards. The same wireless networks that provide users the convenience of untethered access to the internet can also be used to cost-effectively collect data from sensors installed throughout the natural and built environments. In particular, networks of wireless sensors can be used to monitor the environment (e.g., weather conditions, environmental loadings imposed on structures) as well as the physical behavior of infrastructure systems. The placement of dense networks of sensors will result in large sets of data that can lead to data-driven decision making. Data derived from dense wireless sensor networks installed throughout urban environments can also lead to improvements in understanding the loads imposed on infrastructure, assessment of their vulnerabilities to natural hazard scenarios, and real-time assessment of their conditions after a natural hazard event.

Another advancement of the information technology era is the cell phone; cell phones offer the convenience of anytime, anywhere access to telephony service. The recent generation of "smart" cell phones also illustrates the utility of sophisticated software applications that store personal information (*e.g.,* contacts, calendar) on the phone, utilize sensors embedded in the phone (*e.g.,* GPS positioning on maps) and offer internet-enabled tools such as email and texting. With 4 billion cell phones in use globally, they are capable of being used as a powerful regional data-collection network. Currently, these data-collection networks are only starting to be recognized as a tool for sensing society. Non-profit InSTEDD (Innovative Support to Emergencies, Diseases and Disasters) and for-profit Sense Networks both are exploring means of collecting (passively and actively) data and information from cell phone users to assist emergency response efforts to pandemics and natural calamities such as earthquakes. For example, cell phones can serve as a basis for determining the number, location and state of structural inhabitants following a natural hazard event. Other mobile phone sensor modalities including sound, picture and video open additional data types that could contribute to first responder's post-event decision making. While comparatively little research has been conducted on the use of cell phones, their ubiquitous availability renders them a potentially powerful, yet untapped data source.

The aforementioned advances in sensing and telemetry technology now make it possible to install dense sensor networks (potentially millions of sensors) throughout an urban region. However, an important question to ask is, "what does one do with all of the data that can be created by these ubiquitous sensing environments?" Unfortunately, the tools necessary for data interrogation have not kept pace with the rapid development of the sensing and telemetry technologies that make the data possible. With current data management approaches proving difficult to scale to such large data sets, new research aimed at using data mining, machine learning, and pattern classification methods for identifying subtle changes in data are direly needed. Scalable cyberinfrastructure solutions will need to be created that can manage large flows of data, store data, and to autonomously convert data into information of value to decision makers that are involved in natural hazard event planning and response.

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Earthquake Source Scaling for Earthquakes in Taiwan: Implication of Possible High Pga/Pgv from High Stress Drop Earthquakes

We investigated the source scaling of earthquakes (M_w4.6-M_w7.7) from Taiwan orogenic belt, and made the contribution to the global compilation of source parameter to discuss the self-similar and non-self-similar scaling of small to large earthquakes. In total, 19 finite-fault inverted slip models (12 dip-slip, and 7 strike-slip events) using mainly from Taiwan dense strong motion and teleseismic data. We considered a defined effective length and width for the scaling study. We found a scaling of M_o~L^2 and M_o~L^3 for the events less and larger than the seismic moment of 10^{20} Nm, respectively, regardless the fault types. The empirical relationships of the two trends of scaling are given as shown below for future study on simulation and seismic hazard mitigation of scenario earthquakes.

$$\log L_e = (1/2)\log M_0 - 8.08 \quad (\le 10^{20}\,Nm) \qquad \log L_e = (1/3)\log M_0 - 4.84 \quad (> 10^{20}\,Nm)$$
$$\log W_e = (1/2)\log M_0 - 8.08 \qquad \log W_e = (1/3)\log M_0 - 5.38$$
$$\log D_e = 1.68 \pm 0.33 \qquad \log D_e = (1/3)\log M_o - 4.26$$

The distinct features of the scaling are a near constant of slip over wide ranges of magnitudes, and much wider in fault width on fault geometry compared to other observations, especially, in California. Comparison of the regression equations to the Wells & Coppersmith (1986), it shows that the W&C shows an over-estimate and underestimate on length and width, respectively, of fault geometry. In simulation on scenario earthquakes, we suggest to consider the length from W&C and width from this paper as upper bound in the simulation. Our scaling suggests a non-self similar scaling for small to moderate events, while a self-similar scaling for large events. Our study found that the seismogenic depth is a key to control the evolution of the earthquakes. For the events ruptured only within the seismogenic depth the fault width tended to develop simultaneously with the fault length. The earthquake, which has the rupture dimension equivalent to the seismogenic thickness, gives the threshold magnitude to deviate the different scaling relationship of the source parameter to the seismic moment. Our results also found large stress drops events, which with M4.5-6 from the blind faults in the western foothill of Taiwan. These events with small source dimension but with slip of up to about meter. It generates high PGA/PGV, and, thus, provides the threat to the epicentral area regardless the size of the event. In addition to the large earthquakes, the non-self similar characters with high stress drops of these blind fault events require special attention for seismic hazard mitigation.

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Disaster Recovery and Mitigation Planning: A Comprehensive Approach to Societal and Infrastructural Resilience

In the years since Timmerman (1981) first applied the concept of resilience in the disaster/hazards context, disaster resilience has emerged as an often employed yet rarely defined concept in the hazards and disaster literature. Many definitions draw heavily on perspectives suggested by the Resiliency Alliance[1] which generally holds that resilience is the ability of a system to resist or absorb an impact, organize itself to overcome or recover from the consequences of the impact, and adapt or learn from the experience (Carpenter et al. 2001; Folke et al. 2002; Resilience Alliance 2007). In the disaster context, resilience can be defined as the ability of social systems, along with the bio-physical and infrastructural systems upon which they depend, to resist or absorb the impacts (deaths, damage, losses, social impacts etc.) of natural hazards, to rapidly recover from those impacts and to reduce future vulnerabilities through adaptive learning and strategies.[2]

With this definition providing context, strategic planning for rapid and organized emergency response, recovery and rebuilding that seeks to promotes social and infrastructural resilience must be based on at least three critical dimensions. First, any strategic planning must have as its foundation a comprehensive and detailed understanding of current of social and physical vulnerabilities based upon sound

[1] http://www.resalliance.org/1.php

[2] This definition is a slightly modified version of one proposed by RAVON (Peacock, Kunreuther, Hooke, Cutter, Chang, Berke. 2008) and generally consistent with definition proposed by Mileti 1999; Berke and Campanella 2006; Buckle, Marsh, and Smale 2001; Bruneau, Chang, Eguchi, Lee, O'Rourke, Reinhorn, Schinozuka, Tierney, Wallace, and von Winterfeldt 2003; Godshalk 2003; Walter 2004; UN/ISDR 200.

research, mapping and modeling. In a very real sense it must be based on a comprehensive understand of “place.” Second, strategic planning for rapid and organized response, recovery and rebuilding must not only insure that response efforts minimize the losses associated with impacts because of effective and sound emergency response practices, but just as importantly the recovery and rebuilding activities must not replicate or reproduce preexisting vulnerabilities. This is often the Achilles’ heal of recovery and rebuilding efforts; in an attempt to undertake these activities rapidly, all to often preexisting vulnerabilities are not only reproduced, but sometimes exacerbated (i.e., preexisting social inequalities can be exacerbated). Third, we must stop digging. It is often said that when you are in a hole, the first step toward getting out of the hole, is to stop digging. All to often, particularly in large urban systems, development patterns and trends – as reflect in terms of land use patterns, infrastructure development, and social policies and structures – are continuing to dig an ever deeper and larger hole in that they are generating ever higher levels of social and physical vulnerability. In short, strategic planning for social and infrastructural resilience must, of necessity, incorporate effective mitigation action planning to shape not only tomorrow’s actions following a disaster, but also today’s actions that can reduce social and physical vulnerabilities and enhance a systems ability to resist and absorb a future hazard event.

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Mega City/Mega Disaster Reduction

Responding to and recovering from the socio-economic impacts of a catastrophic or extreme event in major metropolitan areas requires comprehensive efforts ranging from developing citizen preparedness and involving all regional stakeholders in rigorous planning, to adopting more stringent building codes and increasing the capacity to respond effectively. These are difficult and expensive challenges that will be driven largely by the real and perceived risk.

As is often the case, however, the high consequence, low probability event confronting most mega cities today will not elicit the sense of urgency or purpose needed to affect real change. Perhaps then, the greatest challenge to mega disaster reduction is to create the interest, involvement and leadership at all levels of government and non-government prompting the development of comprehensive action plans, and then maintaining the momentum required to implement the plan.

To enable such regional planning efforts it is essential to create collaborative consortia that bring together the key stakeholders from all segments of government, non-profits, business, academe and the community. Gaining everyone's involvement is necessary to establish an enabling rapport and trust among the participants that will foster information sharing and coordination. These regional consortia are also essential to identifying and assessing preparedness shortfalls, endorsing the activities chosen for implementation, and undertaking individual and collective solutions to address the gaps.

Beyond constructing the planning framework that addresses catastrophic events on a regional basis, perhaps more importantly, is the need to maintain the momentum that will ensure enduring advancement of the planning efforts. This becomes especially difficult as key stakeholders come and go, budgets ebb and flow and the once catalytic events that precipitated planning efforts grow more distant in the public psyche.

Stakeholders, whether government or non-government, are typically professionals in demanding managerial positions who engage in preparedness activities on a part-time or volunteer basis, or who move on to other activities after a short period of time. As a result, meaningful progress toward a culture of preparedness will ultimately depend on the willingness of these key regional stakeholders to aggressively take on communal planning and implementation, and to set up a systemic means of collaboration required to ensure ongoing success in propagating disaster resilience.

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Tim Reinhold joined the Institute for Business & Home Safety in 2004 as Director of Engineering and Vice President after twelve years with Clemson University where he was a professor of Civil Engineering. He was promoted to Senior Vice President of Research and Chief Engineer in 2008. His professional career includes ten years as a consulting engineer with firms in the US, Canada and Denmark and five years at the National Institute for Standards and Technology. He earned BS, MS and Ph.D. degrees in Engineering Mechanics from Virginia Tech in 1973, 1975 and 1978, respectively.

Dr. Reinhold has conducted research on wind effects and structural resistance for most of his professional career. In addition to directing numerous studies to determine wind loads for tall buildings and specialty structures, he has been heavily involved in research relating to the performance of housing and low buildings in hurricanes and other severe wind events. His research includes post event assessments, model and full-scale laboratory studies, and in situ field structural testing. Tim Reinhold serves on the American Society of Civil Engineers ASCE 7 Committee, the ASCE 7 Wind Loads subcommittee and the ASCE 7 General Requirements subcommittee, served for about eight years on the Southern Building Code Congress International (SBCCI) Wind Load subcommittee and is a past member of the Board of Directors for the American Association for Wind Engineering. Tim has authored or co-authored numerous journal papers, chapters of books and conference publications.

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At the Institute for Business and Home Safety, IBHS, an emphasis is placed on mitigation of the built environment. Much of the damage and related injuries, deaths and disruptions to communities can be reduced by having a physical infrastructure that is better able to resist the event. Table 1 outlines some preliminary thoughts on the elements that affect the performance of the physical infrastructure and organize them in terms of an event timeline.

Table 1. Elements that Affect the Performance of the Physical Infrastructure

	event phase		
Changes in …	Before	During	After
Where you build	➢Land use planning ➢Protective barriers ➢Understanding risks ➢Laws & regulations ➢Incentives/disincentives	➢Event magnitude ➢Evacuation ➢Communication	➢Access to services ➢Access to property ➢Power availability ➢Community planning ➢Risk mitigation
How you build	➢Code adoption ➢Adequacy of code ➢Test standards & ratings ➢Code plus construction ➢Code enforcement ➢Education & certification ➢Public awareness ➢Incentives	➢Life safety ➢Shelter ➢Continued operation ➢Property damage	➢Recovery time ➢Extent of damage ➢Emergency repairs ➢Use of property ➢Rebuilding better ➢Code improvement ➢Community resiliency ➢Recovery costs
How well you maintain	➢Incentives/disincentives ➢Public awareness ➢Education	➢Extent of damage ➢Scale of damage ➢Loss of function	➢Recovery time ➢Recovery costs

Clearly there are many other layers to both the problems and solutions that have to be interwoven in order to mitigate the impacts of a disaster striking a major urban area. Ultimate, each layer must involve actions that change the status quo so that individuals, communities and regions are more resilient when an event occurs. Perhaps a similar matrix can be developed outlining actions that need to be taken before, during and after an event to empower people to take responsibilities for themselves and their neighbors in the immediate aftermath and that help organize the post disaster response in such a way that needs are identified and resources deployed quickly and efficiently.

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Dr. Rodríguez has led a number of field research projects, including to Honduras, following Hurricane Mitch; India and Sri Lanka, following the Indian Ocean Tsunami; and the Gulf Coast, following Hurricane Katrina. He has published extensively in the field of disasters and is the co-editor (with Enrico Quarantelli and Russell Dynes) of the *Handbook of Disaster Research*.

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US-Taiwan Workshop: Advancement of Societal Responses to Mega-Disasters Afflicting Mega-Cities

Recent large-scale disaster events, including the Indian Ocean Tsunami (2004), Hurricane Katrina (2005), the massive earthquakes in Sichuan, China (2008) and in Haiti (2010), as well Typhoon Morakot in Taiwan (2009) have raised our awareness regarding the impact and consequences of these events on a global scale. Moreover, they have brought to the forefront the imperative need to develop effective mitigation and preparedness strategies, including enhancing societal response at all levels, aimed at reducing or alleviating the consequences of such events. Risk and disasters are socially constructed phenomenon; they are influenced by the social and political structure, the availability of resources, stratification and inequality, population pressures (i.e., population growth, density, and distribution), and environmental degradation, among other factors. There are a number of important research areas, which warrant our immediate attention, especially when focusing on the impact of mega-disasters on mega-cities, as outlined below.

Changing Demographic Patterns: The changing demographic landscape, on a global scale, calls for a reassessment regarding our understanding of the societal impacts and consequences of disasters. During the past 60 years, the world population has experienced significant growth, reaching 6.8 billion inhabitants in 2009. Population movements have resulted in expanding settlements in regions with greater exposure to disasters. Also, mega-cities experience unique vulnerabilities including weaker social networks, limited escape routes, and high levels of poverty, especially in developing countries. Significant population influx to major urban areas impacts societies' ability to cope with disasters, generating difficulties in providing shelter and supplying food, water, and medicine to disaster victims. Surges in population density can also result in transformations in the natural landscape (e.g., deforestation), putting populations at greater risk. Population groups mostly settle near coastal regions, in poorly-managed floodplains, and other hazardous zones, thus increasing their vulnerability to disasters. However, researchers have paid limited attention to the interface between changing demographic patterns and disaster impacts and outcomes.

Impact of Disasters on Business Closure and Relocation: Disasters can have an intense and devastating impact on local economies, particularly if businesses do not receive the necessary economic support and disaster relief aid from governments, or do not have adequate insurance coverage. Extensive research is needed to better understand the indicators of business vulnerability and resiliency, as well as the characteristics that impact disaster preparedness and recovery among business owners; on how business closure and relocation vary according to the business sector and the characteristics of business owners, such as class, race/ethnicity, sex, age, household structure, and available resources; and on the role of government in providing resources and support to businesses, focusing not only on disaster response and recovery, but also on mitigation and preparedness.

New and Emerging Technology and Disasters: The successful design and implementation of new technology to better predict and respond to hazard events will ultimately depend on our ability to respond to and integrate the feedback of end-users, including community organizations and leaders. Technology matters, but what *really* matters is the application of the substantive knowledge that we generate regarding how individuals respond (or not) to severe hazard events, and how can we improve their response in order to minimize the devastating impacts associated with these events. Further research is needed on how we can actively engage end-users in identifying their risks, in disaster planning and management, in the development of new technology, and in the communication process. Moreover, we must respond to the needs, interests, and the limitations that end-user communities confront, if we are to minimize the loss of life, injuries, and damage to property.

Risk Communication: Most communication interoperability issues before, during, and after disasters are not technical. The National Research Council (2005:2) argues that better human organization, willingness to cooperate, and the willingness of government to listen to those at local levels are critical factors in making better use of information technology for disaster management. It is also important to highlight that access to multiple sources of information can create confusion and uncertainty among the public, particularly given inconsistent, contradictory, and inaccurate information. There are also technological failures or malfunctions that impact communication of risk information, which adversely impacts public response. Moreover, system interdependency and cascading events increase the population's vulnerability to disasters. The communication of risk information must take into account the societal context and processes in which these events occur. We must continue to expand our knowledge regarding how people and organizations perceive and respond to forecasts, warnings, and risk information, especially in an international context.

Developing Integrated Warning Systems: With continued improvements in monitoring, detection, and mass communication technology, the social and organizational features of integrated warning systems are of paramount importance in saving lives and reducing property damage. These systems should focus on emphasizing communication, education, and raising awareness, as well as responding to the needs of the population at risk (e.g., "people-centered" warning systems). This will also require enhancing communities' economic capacity and paying particular attention to issues such as poverty, inequality, and sustainable development.

Enhancing Resiliency of the Health Care System**:** Hospitals are in the business of handling emergencies, crises, and disasters and yet major disasters (such as Katrina and the earthquake in Haiti) reveal the vulnerabilities of already deteriorating health care systems. Moreover, these disasters present extraordinary sets of demands, which health care systems are not able to manage or respond to. However, disaster research focusing on the impact and consequences of major disasters on health care systems is limited, especially in the context of mega-disasters in mega-cities. Disaster planning and management strategies must consider how medical and health care facilities will maintain their operations and functionality in the absence of essential services and during the disruption of their inter-organizational systems. Planning, access to adequate resources, networking, effective communication and coordination, as well as training and education of medical staff is essential if we are to develop a resilient health care infrastructure that will be able to provide the much needed medical services to populations impacted by disasters. There is also an immediate need to focus on the physical and structural aspects of hospital buildings, including compliance with building codes that will increase their resiliency to high winds, floods, and earthquakes.

Governmental Response to Disasters: Many major disaster events, such as those mentioned above, bring to the forefront the inefficiency of governments in dealing with events of such magnitude. These situations also highlight the reactive rather than proactive nature of governments, placing emphasis on disaster relief rather than on mitigation and preparedness. Additional research is needed not only focusing on government preparedness and response, but on their role in building disaster resilient communities.

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Challenges in Evacuation Route Planning for Incident Management

The recent loss of lives and traffic jams (Figure 1) for tens of miles as hurricanes Rita and Katrina approached the Gulf coast demonstrate the enormous difficulty in evacuating urban areas [6]. Besides hurricanes, evacuation may be necessary due to other potential disasters, e.g., fire, terrorism, and nuclear or chemical plant accidents. Thus, the local emergency management community engages in evacuation route planning and required drills, e.g., fire-drills in schools and large office buildings.

Figure 1: Hurricane Rita Evacuation (Best viewed in color), Source: National Weather Service, Dallas News.

During emergency evacuation, transportation scientists, first responders and other stakeholders pose many questions requiring spatio-temporal computations, e.g., what are the best routes (or transportation modes, shelters, timeslots) to evacuate affected locations? How many evacuees are likely to use each route, shelter, and logistics facility? Challenges arise due to violation of key assumptions behind transportation planning tools, e.g. microscopic traffic simulators, and popular shortest path algorithms. For example, transportation planning tools (e.g. DYNASMART, TRANSIM) rely on game-theory-based Wardrop equilibrium [9] among selfish commuters, who may change routes between trips to/from work. However, evacuation traffic may not exhibit such behavior. In addition, common shortest path algorithms (e.g. Dijktra's, A*) are based on dynamic programming and thus assume a stationary ranking of alternative routes [1,8]. A community may prefer a freeway-based evacuation route during non-rush-hours, but a different route during rush-hours, since the ranking of alternative paths changes over time possibly due to congestion. In addition, these routing algorithms do not account for capacity constraints of transportation links, particularly when the number of evacuees is large.

Currently, evacuation route plans are often hand-crafted for selected scenarios, since algorithms methods [5] based on linear programming take unacceptably long time (e.g., hours or days) to recommend best evacuation routes for large metropolitan areas (e.g., Houston). These methods address time-varying ranking of routes by using the time-expanded graph (TEG) representation. As illustrated in Figure 2(B), TEG replicates a graph representing the transportation network across various time-points in the evacuation time-period. Additional edges are added to link network copies across time. Link capacity and travel-time constraints are modeled as linear constraints. Linear programming formulation is used to derive solutions. Post-processing is used to derive evacuation routes. While this approach is reasonable for small towns, it does not scale up to larger problems. Consider metropolitan transportation networks with millions of nodes and edges with evacuation lasting hours or days. TEG representation leads to excessive duplication of the transportation network across time-points and a very large set of linear constraints, which increase computational time to hours or days. In addition, this approach needs an estimate of upper bound on total evacuation time to determine the number of copies of transportation network needed in a TEG representation. Incorrect estimate of upper bound on total evacuation time may lead to either a failure to produce any solution or excessive computational costs.

Our recent work on the Capacity Constrained Route Planner (CCRP) [7] introduced a novel representation, namely, Time-Aggregated Graph (TAG), which eliminates redundant information to yield a more compact representation than TEG. As shown in Figure 2(C), TAG models node/edge attributes as functions of time rather than fixed numbers. Thus node/edge capacities, node occupancies, etc. are modeled as time-series. Second, it iteratively considers all pairs of sources and destinations. Each iteration schedules evacuation of a group of evacuees across the closest source-destination pair. Special graphs construction is used eliminate redundant computation in this step. Non-stationary ranking of alternative routes during an evacuation is addressed by a linear-cost earliest-arrival-index on input TAG with travel-time-series [3,4].

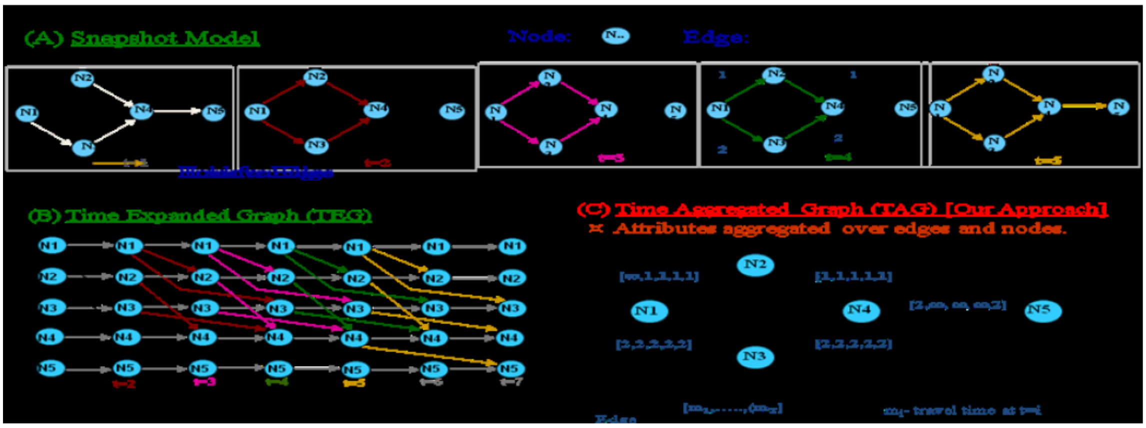

Figure 2: Representations of Time-evolving Transportation Networks (Best viewed in color)

Experimental results [7] with Minneapolis-St. Paul metropolitan scenarios show that CCRP is an order of magnitude faster than competing methods. Evaluation with the Monticello, MN, nuclear power plant scenarios (Figure 3) show that CCRP lowers evacuation time relative to existing hand-crafted plans by identifying and removing bottlenecks, by providing higher capacities near the destination and by choosing shorter routes. It was used to plan evacuation routes for many homeland security scenarios around multiple locations, time-of-the-day, and transportation modes. It facilitated a transportation science discovery that encouraging able-bodied evacuees to walk (instead of letting them drive) reduces evacuation time significantly (by a factor of 3) for small area (e.g., 1-mile radius) evacuations.

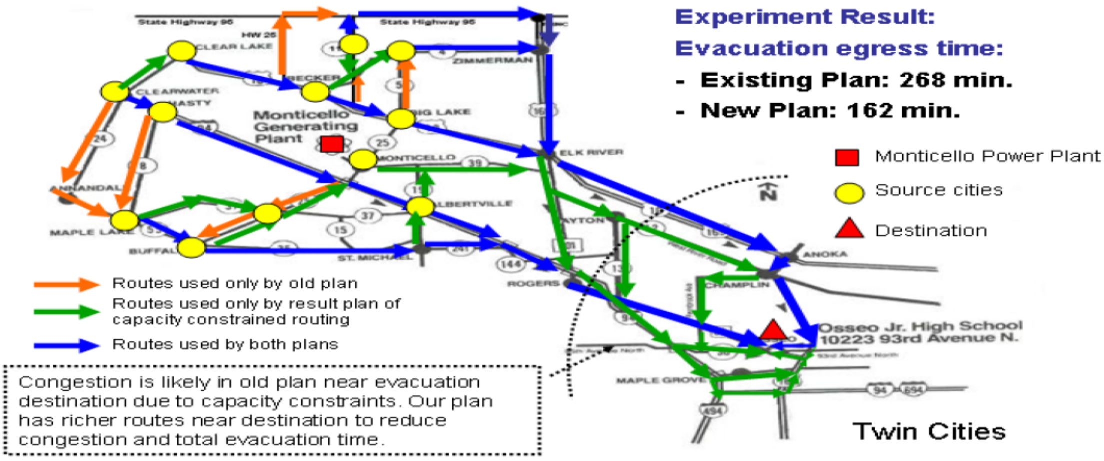

Figure 3: CCRP improved evacuation routes for Monticello Nuclear Power Plant (Best viewed in color)

There are many interdisciplinary research challenges related to the evacuation planning problem for the following reasons. Recently, I was invited to deliver the annual

Dangermond lecture at U.C. Santa Barbara, which accorded a unique opportunity to talk to evacuees of the recent Santa Barbara fires, and evaluate assumptions of CCRP in the context of forest-fire evacuations. CCRP assumes that individual evacuees will act independently. However, Santa Barbara evacuees preferred group evacuations of members of a household. For example, parents went to schools to pick-up children before leaving town. Third, CCRP looked for system-optimal evacuation routes, which may not be equitable for special-need groups (e.g., children). These insights beg the following question: “How do we develop computationally tractable evacuation planning models that honor the constraints of equity in evacuation, household requirements and the non-stationary route rankings?”

Modeling household cooperation and equitability are complex social science issues, which may not be amenable to computer algorithms. In collaboration with social scientists and policy makers, we need to characterize decision-support roles for computational methods. For example, computation may shortlist alternative evacuation plans along with relevant metrics (e.g., total evacuation time, equity, fairness) to reduce the enormous set of possibilities in front of decision makers and aid decision making process. Even to play such a role, current evacuation planning algorithms will need to be revised possibly as multi-objective optimizations. A novel approach may be based on eliminating solutions which are inferior to other solutions on all (or almost all) objectives. Recent computing literature is exploring skyline query processing for location based services to address similar problems. It may be useful to bring these approaches to evacuation route planning problem.

Of course, traditional optimization approaches may be considered using a total ranking of objectives, or simultaneous consideration of a weighted sum of different objectives. Under the former paradigm, transportation network and shelter capacities may first be divided among population segments in an equitable manner using preliminary models of equitability from policy makers and social science researchers. Then, households within each population segment may be assigned to appropriate shelters with available capacities for that segment. Finally, routes may be recommended for individuals within each household to reach a common shelter possibly by getting together at some place in between. If this paradigm of dealing with equitability first and household constraints later leads to unacceptable evacuation-routes, then one may investigate other ways, e.g., combining equitability and household constraints into a unified measure of solution quality, and exploring algorithms to improve the unified solution quality measure.

Other challenges include exploration of new ideas to expand transportation system capacity or to manage demand. For example, contra-flow [6] may be used to reverse direction of a majority of inbound lanes of a highway to increase outbound capacity. Governors of Texas and South Carolina asked for use of contra-flow during Hurricane Rita (2005) and Hurricane Floyd (1999). Hurricane evacuation plans in Florida and New Orleans include contra-flow plans. However, current contra-flow plans are hand-crafted and computational methods may improve those further [2] while meeting resource constraints. Phased evacuation [6], where more vulnerable areas are evacuated before less vulnerable ones, has the potential to reduce overall evacuation times by reducing congestion, which decreases highway capacity. New Orleans evacuation plans include phased evacuation. However, the plans are hand-crafted and computational methods may be helpful. For example, evacuation route planning methods may be generalized to recommend evacuation schedules taking into account conflicts among evacuation routes of various communities. Computer tools may allow concurrent evacuation of communities whose evacuation routes do not have conflicts. This may improve current phased evacuation plans.

It is important to improve modeling of other transportation modes such as public transportation by characterizing their capacities, speeds, etc. We also need to improve accuracy of input datasets related to numbers and locations of evacuees and available (rather than maximum) capacity of transportation networks possibly by using emerging datasets from cell-phones, global-position systems, and sensors on highways.

Reference

[1] T. H. Cormen, C. E. Leiserson, and R. L. Rivest. Introduction to algorithms. McGraw-Hill, 1990.

[2] S. Kim, S. Shekhar, M. Min, Contraflow Transportation Network Reconfiguration for Evacuation Route Planning, IEEE Transactions on Know. and Data Eng., 20(8), 2008. A summary in Proc. ACMGIS 2005.

[3] B. George, S. Shekhar, and S. Kim. Spatio-temporal network databases and routing algorithms. University of Minnesota. CSE Technical Report No. 08-039, 2008. (A summary of results appeared in Proc. Symposium on Spatial and Temporal Databases, Springer LNCS 4605, 2007).

http://www.cs.umn.edu/research/technical_reports.php?page=report&report_id=08-039

[4] B. George, S. Shekhar, Time-Aggregated Graphs for Modeling Spatio-temporal Networks, Journal of Data Semantics, Volume 11, 2006 (Springer LNCS 5383, 2008). (Initial results Workshop on Conceptual Modeling for GIS in conjunction with Intl. Entity Relationship Conf., 2006).

[5] H. W. Hamacher and S. A. Tjandra. Mathematical modeling of evacuation problems: State of the art, Pedestrian and Evacuation Dynamics, Springer Verlag, 2001.

[6] T. Litman. Lessons from katrina and rita: What major disasters can teach transportation planners. Journal of Transportation Engineering, 132(1), American Society of Civil Engineers, 2006.

[7] Q. Lu, B. George, and S. Shekhar. Capacity constrained routing algorithms for evacuation planning: A summary of results, Proc. Intl. Symp. on Spatial and Temporal Databases, Springer LNCS 3633, 2005.

[8] A. Orda and R. Rom. Shortest-path and minimum-delay algorithms in networks with time-dependent edge-length. Journal of the ACM, 37(3):607–625, 1990.

[9] J. Wardrop, Some theoretical aspects of road traffic research, Proceeding of the Institution of the Institution of Civil Eng., 2(1), 1952.

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He has been working in the area of natural hazards for most of his career and his professional and research interests in the area range from various aspects of static and seismic slope stability to rainfall initiated debris flows. He has participated in a number of post-disaster investigations including the 1989 Loma Prieta, 1994 Northridge, 1995 Kobe, 1999 Chi-Chi, 2008 Sichuan, and 2010 Chile earthquakes. He has investigated debris flow initiation in 1982 San Francisco Bay Area, 1984 Utah, and 1999 Taiwan.

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Societal and Infrastructure Resilience: Strategic Planning for Rapid and Organized Emergency Response, Recovery, and Rebuilding

In order to consider the challenge posed by the workshop organizers it is worth to first review some of the most recent major natural disasters to see what if any lessons can be discerned to assess what, if anything could have been done in anticipation. The events that come to mind is are the great earthquakes and associated tsunamis, hurricanes and typhoons, and massive floods. The one thing they all have in common is that they are created by well known geologic and atmospheric process and as such there is ample evidence in the geologic record for the past occurrence of these events. What is it then that puts large human populations at risk from these events and how do these events differ in terms of their impact?

The most immediate and most readily apparent difference is the ability to issue warnings and to make preparations in response to the warning. At present, while we can assess the vulnerability of a region to earthquakes, we do not have the ability to predict them. In contrast, hurricanes, typhoons, and floods can be forecasted days ahead. As a result the kind of response planning used to deal with events that can be anticipated in the aggregate, but not specifically predicted, such as earthquakes, effectively differs from the type of preparations that are possible for events that are predictable.

Let us consider the most recent large earthquakes such as the Chi-Chi Earthquake of 1999, the M 9.0 Sunda Trench earthquake and tsunami of December 6, 2004; the Wenchuan Earthquake of May 12, 2008, and the most recent M 7.2 earthquake in Haiti and the M 8.8 earthquake in Chile. None of these earthquakes occurred in a zone or location that has not been previously identified as a seismogenic zone, however, there was an enormous difference in the number of casualties and damage to infrastructure. In the case of the Wenchuan and Haiti the recurrence interval of past events was sufficiently large as to imply unrealistically low expectation of vulnerability and the loss of life was the result of a lack of adequate codes to assure seismically safe infrastructure. In the case, of the Sunda Trench earthquake, the enormous loss of life was principally the result of a massive tsunami on a scale that has not been observed for 100's of years. In contrast, the casualties were relatively low, for the density of population in the affected region in the Chi-Chi Earthquake, and remarkably low in the most recent earthquake in Chile, because modern infrastructure in both countries has been built to a very high standard of earthquake resistance. Thus, it is readily apparent that appropriate building codes when properly implemented are highly effective in this case.

In comparison to earthquakes, which can cause severe but highly localized damage, major storms and floods including tsunamis, while predictable, cannot be simply addressed by building codes. The regions affected tend to be extensive and all infrastructure within those regions is at risk. As a result, while adequate warning can be issued, warnings in themselves are not enough if the infrastructure is not designed to avoid the areas of the highest risk and effective means of evacuation are not provided as one of the options. So, in this case, land use and urban planning plays a very important role.

As there are differences in the way the various events occur there are as well important differences that have to be considered in terms of post-event, post-disaster, response. For example, while it is quite readily feasible to built earthquake resistant fire stations, police stations, hospitals and other critical facilities which then can be immediately operational after a major earthquake, inundation by tsunami, floods, or debris flows is best managed by moving the critical resources out of the threatened zone. A direct consequence is that post-earthquakes local jurisdictions can retain full effectiveness, whereas in areas affected by tsunamis, hurricanes, typhoons or floods, much of the assistance has to come from the outside as much of the infrastructure is flooded or buried. Recognition of this basic difference is essential to adequate post-event planning.

In all of the above, it is important to consider the socio-political and socio-economic landscape. Human society is relatively well adapted to deal with immediate crises or to plan for events that are clearly regular enough in ordinary life. However, the challenge facing our society at every level is how to deal with events that are rare enough that the may occur once or never in an individual's life time.

Thus the workshop needs to consider the broader societal issues while trying to put forth specific ideas that could be adopted by communities and governments in order to provide a more resilient and responsive infrastructure.

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Openis: Information System for Disaster Management

This position paper presents research and advanced development opportunities found in the process of fleshing out the architectural foundation and design of an open information system for natural disaster management. The system, called OpenIS for short, aims to facilitate the access, mining and fusion of data and information by application systems and services that are designed to support decisions and operations during all phases of disaster management, including disaster prevention and preparedness, monitoring and warning, response and recovery. In particular, an objective of OpenIS is to weave together real-time and archival data and information from diverse sources so that it can offer application systems and services less fragmented and more trustworthy information with higher availability.

At the core, OpenIS appears to the applications and services relying on it to be a system of physical and virtual data repositories. In essence, the system provides a flexible framework supported by infrastructure components and tools for the incorporation and collaboration of independently developed and maintained data and information sources and applications. Real-time and historical data and information provided by the sources range from remote and in-situ sensor data collected and contributed by an open sensor information system (OpenSensorIS) to other types of real-time data such as time-varying meteorological models, traffic densities and road conditions from weather bureau and transportation agencies. OpenIS will also make available census data and other relevant geographical information; machine-readable government information on standard operation procedures, contacts, etc.; and news, eyewitness reports, and other types of soft information. A key component of OpenIS is a suite of trusted access control mechanisms capable of supporting diverse normal and emergency information access policies: The system should enable individual data stakeholders from government, enterprises, research communities, private organizations and so on to easily define and tailor the policies best suited to govern when, under what conditions, to whom and to what extent their data are open. The system also needs to provide privacy protection and information flow barriers to safeguard the confidentiality of information flowing through OpenIS for disaster management purposes.

OpenIS also aims to provide a wide range of information filtering, fusion, extraction and mining tools and social networking, syndication and feed services. By doing so, the system aims to ease the effort and reduce the time needed to develop disaster management applications.

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Bill Spencer received his Ph.D. in theoretical and applied mechanics from the University of Illinois at Urbana-Champaign in 1985. He worked on the faculty at the University of Notre Dame for 17 years before returning to the University of Illinois at Urbana-Champaign, where he currently holds the Nathan M. and Anne M. Newmark Endowed Chair in Civil Engineering and is the Director of the Newmark Structural Engineering Laboratory. His research has been primarily in the areas of smart structures, stochastic fatigue, stochastic computational mechanics, and natural hazard mitigation. He was the first to study and design magnetorheological (MR) fluid dampers for protection of structures against earthquakes and strong winds, overcoming the inherent limitations of existing passive energy dissipation systems, as well as power-dependent active control systems, which are in common use today. His most recent research on structural health monitoring systems and smart wireless sensors integrates advanced computing tools with smart sensors, to provide a functional platform with self-interrogation capabilities. He led the Jindo Bridge monitoring project in South Korea, which constitutes the world's largest deployment of wireless smart sensors to monitor civil infrastructure to date. He is a Fellow of ASCE, a Foreign Member of the Polish Academy of Sciences, the North American Editor in Chief of Smart Structures and Systems, and the president of the Asia-Pacific Network of Centers for Research in Smart Structures Technology.

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Bio-Inspired Smart Sensor Networks for Adaptive Emergency Response

One of the most urgent and important challenges confronting society today is that of addressing the vulnerability of our civil infrastructure to mega disasters. In 2007, there were 414 reported natural disasters globally, affecting 211 million people, killing 16,847, and leading to over $74.9 billion (USD) in damage (CRED, 2008). These staggering numbers highlight the social and economic costs that society must bear, costs that can be reduced by more effective response and recovery efforts.

The recent disasters such as Hurricane Katrina and the Haiti Earthquake have brought real-time images of destruction into our homes like we have never seen before. Technology has succeeded in bringing global attention to these tragedies leading to fundraising efforts focused on relief and recovery and policy changes designed to mitigate future tragedies. However, in terms of saving lives, the first few hours after an event are the most critical. In these times, technology has in a sense failed to achieve its potential. During the Haiti earthquake, CNN reported that many victims were texting relatives on mobile devices, but not being located or rescued by authorities. Indeed the world is inundated with a vast array of sensors and networking in the form of mobile phones. There is at least one mobile phone subscription for every two people in the world. That is to say in a mega city during a mega disaster, the distressed would likely have access to a mobile phone. This preexisting telecommunications infrastructure can be adapted to form a decentralized and flexible communication network in the event of a mega disaster. Moreover, biological principles can be employed to cope with problems that frequently exist in the chaotic and inhospitable environment of disaster relief operations.

Mobile phones currently possess capabilities to sense (neurons) and communicate (synapses). Sensed information paralleling biological systems such as sound, video, motion detection, and GPS are currently standard capabilities of “smart” phones. If the user themselves are responsive, such sensory input is extended to the extent of which a human can perceive. These mobile phones are capable of traditional long distance communication via cell towers, with the potential of short distance communication through ad-hoc networking. Through efficient acquisition and processing of data followed by distribution of task-relevant commands, mobile phones could provide a decentralized means by which to relay critical information to rescuers and survivors. Disaster-enabled mobile phones could be a part of survivor status assessments, survivor and hazard locating, rescue efforts for trapped victims, and controlled evacuations. Such an innovative extension and use of existing technology will require interdisciplinary cooperative efforts between civil engineering, computer scientists, sociologists, and neurobiologists.

User oriented solutions cannot be implemented without engaging the public in awareness and education campaigns. In prototyping a mobile phone assisted response and rescue plan, challenges for establishing the communication framework and methods for engaging the residents of these mega cities must be outlined. Professionals, including police, firemen, hospital workers, and government workers must be trained to use this technology as a tool alongside their normal response and rescue activities. Moreover, these professionals should be an integral part of creating the system such that their needs in a mega disaster are met. At the same time, we must remember that mega disasters are infrequent and chaotic. In this regard, such a system should remain as simple as possible from the user's perspective.

Pushes to include IT innovations in disaster management before, during, and after mega disasters has been the focus of considerable research. However, the hierarchical nature of many approaches is too inflexible to address the unpredictable and evolving needs of the distressed. Currently, real-time information is reported through voice communication with centralized emergency call stations. This centralized system is adequate for isolated emergencies, however quickly becomes overloaded during wide-spread disasters.

A dense network of smart sensors operating under decentralized networking protocol holds much promise as a flexible and efficient response and recovery tool. Utilizing the existing capabilities of mobile phones, this framework is much closer to fruition than otherwise possible.

References

Centre for Research on the Epidemiology of Disasters (CRED) (2008). “Annual Disaster Statistical Review, The Numbers and Trends 2007.” Jacoffset Printers, Melin, Belgium, May, 2008.

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Dr. Sung research interests include performance-based design of the structure, structural optimization and natural hazard mitigation of the bridges. Dr. Sung was awarded the Best Paper offered by the Journal of Structural Engineering as well as the Journal of the Chinese Institute of Engineers in 2005 and 2007, respectively.

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Whey-Fone Tsai is a senior research scientist in the National Center for High-performance Computing (NCHC), National Applied Research Laboratory (NARL). He is the project investigator of the multidisciplinary project, “The development of the near-real-time and 3D high-resolution global earth observation platform for environmental and disaster monitoring,” at NARL. He received his Ph.D. degree in Civil & Environmental Engineering from the University of Iowa. He had been Research Associates at Concordia University, Canada, and the University of Iowa. He was the Deputy Director of NCHC during 1998-2009. He had been participated in the US-Taiwan NSF-NSC bilateral collaboration meetings during 2002-2008 in the subject of Cyberinfrastructure development and applications to science and engineering. Also, he has been the steering committee member of the NSF-funded international organization, “Pacific Rim Application and Grid Middleware Assembly” Since 2003. Dr. Tsai’s recent research interests are in the cyberinfrastructure development associated with vertical integration of sensor network, 3D GIS, and relevant cloud service.

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Challenge of Building Sensor Network and Cyberinfrastructure Pipeline for Effective Response to Natural Disaster Events

Taiwan is densely populated and situated in a highly seasonal subtropical region dominated by typhoon-generated hydrology. Due to radical climate change, serve precipitation, flood and induced inundation and landslide occur frequently beyond the expected scale during typhoon season. When this type of mega scale disaster occurs within the densely population mega city, it would be much more difficult to predict and respond in short term. This leads to significant challenges for practices in effective disaster reduction and timely support for authorities to mitigate disaster. For a quick response to natural disaster event, the near real-time remote sensing observation and image processing are very crucial to get insight into the scenario of the disaster rescue and response. Therefore, the National Applied Research Laboratory (NARL) has conducted the multidisciplinary project, "Development of near real-time, high-resolution, global earth observation 3D platform for applications to environmental monitoring and disaster mitigation." The platform encompasses Formosat-2 space borne images incorporated with data warehouse/fusion and high-performance visualization technologies, attempts to implement a near real-time and semi-automation image processing procedures, and through a platform to link with monitoring sensors, end-user disaster prevention database, analyzed model and assessment methods for supporting decision maker to prompt master the disaster scenario and assess the disaster damage. The most challenge work is to build the effective pipeline that connects with various technologies associated sensor network and cyberinfrastructure of environmental monitoring, and especially the collaborators in the loop.

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Akira Wada is a member of structural engineering research center at Tokyo Institute of Technology. He graduated from the department of architecture and building engineering at Tokyo Institute of Technology at 1968 and the master course at 1970. He became a member of structural engineering division of Nikken Sekkei Ltd., one of large architecture and engineering design firm in Japan. He got a degree of doctor of engineering at 1981. He returned to Tokyo Institute of Technology as an associate professor, 1982. He was promoted to a professor at structural engineering research center of same Institute in 1989. He had been staying in USA as a foreign lecturer at the University of Washington on 1984 and as a visiting professor at Massachusetts Institute of Technology on 1991. His research interests are structural engineering of architectures and buildings, seismic design, seismic isolation, damage controlled design and computer simulation of structures. Architectural Institute of Japan gave a research award of 1995 for his work “Analytical and experimental researches of nonlinear behavior of building structures”. Architectural Institute of Japan gave an engineering award of 1993 for the work of his colleagues and him “Invention and realization of damage controlled structures”. He is one of most active researchers in seismic design of building structures in Japan and he is a chair or a member of many research committees concerning these fields in Architectural Institute of Japan, Japan Society of Seismic Isolation, Building Center of Japan and Japan Society of Steel Construction. Now, he is a collective member of the Science Council of Japan.

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Seismic Design for Resilient City

Introduction

The Industrial Revolution started in the 18th century in Britain. We exceeded modern ages, and had arrived at the present age. Now, People in the world are living in the multistory apartment houses and making jobs in the high-rise office buildings, too. The earthquake hardly occurs in Britain, France, and the east coast of the United States. The civilization extended to the west coasts of the United States and Asian countries, it came to build a lot of buildings. Population increased in the big city. Then, many big seismic hazards have happened in the 19th and 20th centuries.

Difficulties in reducing seismic disasters

Human life is about 80 years and building life is 40 to 100 years. Interval of big earthquake hitting one place is 100 to 2000 years. Optimists tend to think next big earthquake will not come while they are alive. It is easy understood that reducing seismic disasters is so difficult.

Seismic design of buildings

Each owner of a building thinks the performance of only his building in seismic design. The owner and structural engineers of his building consider the occurrence of big earthquake in his building life span. When the life span of building is shorter, the design earthquake level would be smaller automatically.

Seismic design for urban city

The seismic issues of a city cannot be solved if the seismic resistance of its individual building is determined only from the relationship between the life of a single building and the earthquake occurrence in its life span.

Could you apply largest level of earthquake to design of a building?

A criticism would arise from society if individual building is to be designed for the largest level of earthquake ground motion. Actions to legally demand excessively high seismic performance are interpreted as a violation of property right of people. Then, we need new technology having high performance without expensively cost.

Conclusions

Engineers and Researchers in the field of the earthquake engineering did many researches in these 100 years. The developments of the seismic isolated structures, the passive controlled structures and seismic retrofit technologies were advanced. We have high-speed computers and good software. We can use high & low strength steel, high strength concrete and new materials for building structures. Hereafter, we have to consider not only individual building but also the city, when we want to design resilient city against big earthquake. We have to apply these new technologies to all buildings in all earthquake prone countries.

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An Integrated Risk Assessment on Bridges

The comprehensive and quantitative risk assessment of bridges under the mega-hazards should include structural, hydrologic, metrological, geotechnical, geophysical, numerical and experimental investigations. An information platform that archives all the fundamental and historical data related to the lifeline infrastructures to be evaluated is the core of the whole risk assessment and management. However, some data for the risk analysis were not collected or invalid due to the environmental effects and then the nondestructive testing (NDT) techniques can be used to identify the current conditions of the structure and its analysis domain. These data will be used to establish the risk analysis model. Since the ultimate and failure states of the structures under natural hazards are expected to be predicted for the risk assessment, advanced simulation techniques are required to handle the complicated behaviors like the fluid-structural interaction, multi-bodies dynamics, large deformation and collapse of structures. Hence, an integrated risk assessment mechanism including data management, NDT and 3D nonlinear, dynamic computation analysis should be established to provide a comprehensive and effective assessment.

Fig. 1 Collapse of the Shuang-Yuan Bridge of Taiwan during Typhoon Morakat in the August of 2009

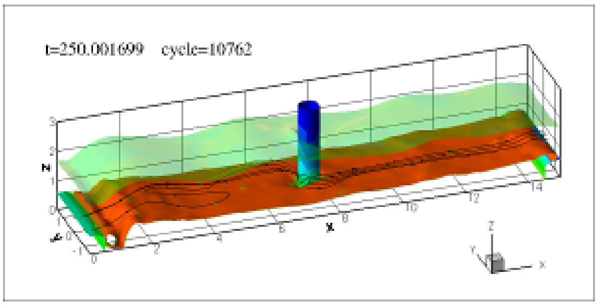

Fig. 2 Simulation of local scouring at a pier

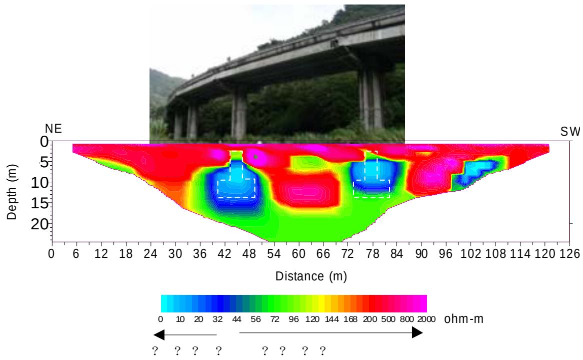

Fig. 3 Detection of the foundation size by resistivity image profile (RIP)

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Nonlinear Dynamic Response of Structure Undergoing Plastic Deformation

It is customary to install gauges on a structure and measure responses of the structure during an earthquake or when the structure is subjected to wind loads. Lots of data can be collected, but what physical causes making the data nonlinear is not straight forward and should be investigated. The nonlinearity can be due to plastic deformation, fracture of local structural elements, or other causes. This investigation should start with the dynamic analysis of a very simple structure using a realistic material model so that specific dynamic response patterns due to plastic deformation/fracture can be determined. The method can then be expanded to obtain response patterns of more complicated structures in further investigations. The challenge is two-fold. The first one is the formation of a realistic material model that accounts for plastic deformation/fracture, and the second challenge is the analysis of data collected from gauges installed on the structure. Traditional method of data analysis may not be able to successfully identify the change in the data spectrum when plastic deformation occurs and other more effective methods of data analysis may be required. The HHT (Hilbert-Huang Transformation) adaptive analysis proposed by Norden Huang is quite powerful and it has been found that it could differentiate the frequency spectra of a structural response in the elastic range from one undergoing plastic deformation.

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Landslide-Induced Disasters in the Central Taiwan

The geological formation of Taiwan, where is located at an active tectonic plate, is so young and unsteady to be prone to sloping and landsliding. The occurrence probability of landslide is comparably high in the central Taiwan, especially after the Chi-Chi earthquake in 1999. Besides, climate change increasing the rainfall intensity and human cultivation changing the landuse exacerbate the damage of the landslide catastrophe. In the past decade, hundreds of hillsides and landslides were identified in the central Taiwan due to the fragile geological environment and heavy rainfalls. During Mindulle and Morakot typhoons, which are the most serious rainfall events in the last decade, the catastrophic investigation of the disaster scene, including field survey, outcrop investigation, and remote sensing investigation was executed to reveal the inundation for disaster response. Applying GIS and GPS, field survey was carried out for prime investigation immediate in the end of the flood. SPOT and FORSAT-II satellite and airborne images provided temporal and spatial information for inundation investigation and scenario simulations. Not limited to hill slope sliding, the landside-induced disasters are complex and include debris flows, river bed lift-up, levee failure caused by hyper-concentrated sediment flow, and landslide dam. The river bed has been significantly rose up by sediments originating from landslides in the watershed that threatens the structures and property in the downstream, such as levees, bridges, farms, and houses. The landslides nearby the river bank stock the stream and detour flow, and even generate a landslide dam threatening the downstream areas. Considering the detriment of landslides, a basin management strategy for the rivers in the mountainous area should have revolutionary thoughts beside traditional water-only concern.

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George C. Yao is a professor in the Department of Architecture at the National Cheng Kung University. He received his Ph.D. degree in Civil Engineering from the University of Buffalo, USA. He is also the chief editor of a national accredited journal, Journal of Architecture. In the past 15 years, his research is devoted to the application of structural technique, such as structure analysis and modal testing, on non-structural component improvement against earthquakes. Several patents were developed as a result of his research. He also serves as an earthquake consultant for several high-tech factories in Taiwan. In the last two years, he participated in an international working group to develop an ISO standard for non-structural element.

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Emergency Shelter Design and Management for a Friendly Environment

During the Morako flooding, one of the problems discovered is that although government issued warning signals for the imminent danger of mud flow and land slide but quite a few residents refused to move out of their home to the emergency shelters. Some of them suffered serious consequences and the government was blamed for not doing enough to protect her citizen. If natural disasters are going to be frequent in the future, what can be done to reduce these problems except using public authority to a forced evacuation by law.

After site survey to a couple of emergency shelters and conduct questionnaires on refugee in the shelters, some conclusions are drawn:

1. Emergency shelters are not safe. Because it was an ad-hoc stay, a lot of people were thrown into a large space, such as a school auditorium or community center, to spend several days together. These places are not designed to accommodate people to their individual needs. Refugees may lose their property, can not get enough sleep, and some times sexually harassed.

2. Pets are not allowed in the shelters. In many families, pets are like members in the house. In an emergency shelters, animals are not allowed inside. Therefore, people would rather gamble to stay at home to accompany their pets than moving into a shelter. There are incidences that people died because of this reason.

3. Social support at the shelter is inadequate. When people moved into a shelter, they need to start making plans for the aftermath. But refugees generally come to a shelter with nothing. Therefore adequate social support from the government and volunteer groups is extremely important. Otherwise, refugees may not want to leave their home next time when an emergency happens.

4. Location of shelter should be close to home. After the imminent danger is over, refugees want to check back on their house and plan for the recovery. A long distance travel from shelter back home may discourage people to go to the shelters.

Recommendations for improvement

1. Adequate pre-disaster planning and design on the shelter space is important for a more friendly shelter environment.

2. Reorganization of disaster management for a more efficient administration is important.

3. Pet issue need further research.

US experience may be a starting point for Taiwan to improve.

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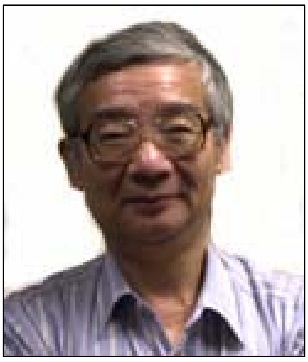

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A Modeling System for Disaster-Reduction Research

This position paper calls for the establishment of a modeling system that is integrated with scientific research, information, instrumentation, and observation in disaster reduction and research platform (Fig. 1). The need of such a modeling system and the role it plays in disaster-reduction research is described below. Physics-based modeling system with the design capability of integrating river networks, land surface processes, and subsurface media play the central role in flood and inundation forecast and the attendant mitigation managements. For these to materialize, scientific research on hydrologic cycle is needed to provide watershed processes for incorporation into the core simulators of the modeling system, which in turn will provide modeling tools to validate research hypotheses and discover new processes. Information synthesis is needed to provide the modeling system with filtered data upon the request of needs. Observation is needed to provide the modeling system with raw data upon the request of needs. Although instrumentation may not have direct interaction with the modeling system, it is needed to provide scientific research and observation with measuring tools up the request of needs. By providing measuring tools, instrumentation enables observation and scientific research to obtain data and to derive scientific processes that feed into the modeling system to achieve scientifically improved predictions. The success of these cyclic interactions hinge on the modeling system that should have consisted of physics-based simulators to enable rigorous simulations, graphical pre- and post-processor interfaces to facilitate friendly live simulations, and high performance computing to enable required lee-time forecast.

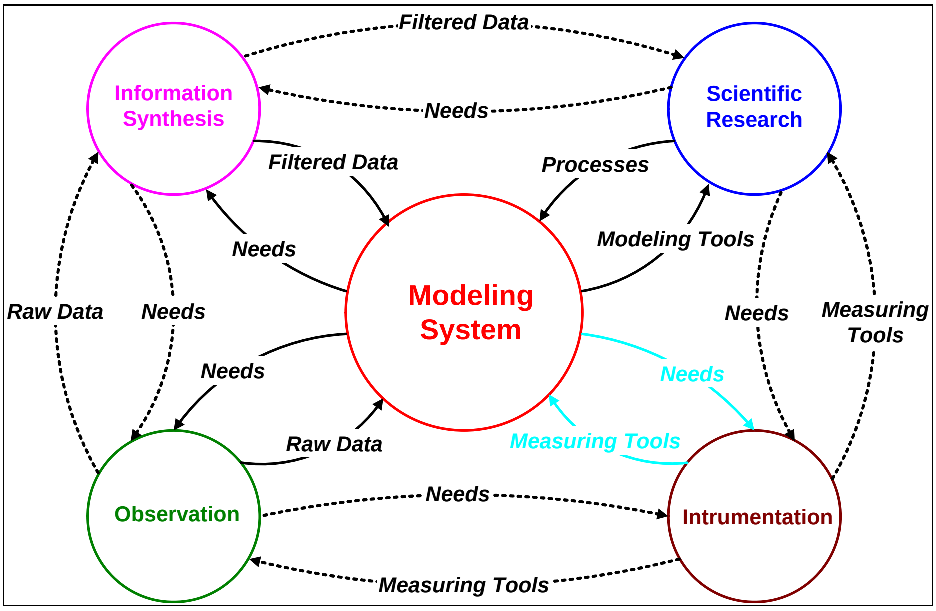

Figure 1 A Platform for Disaster Reduction and Research

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Kuang-hua Hsiung is the Commissioner of the Taipei City Fire Department, also serving as the Executive Director of SFPE Taiwan Chapter. As a distinguished Associate Professor at the Graduate School of Fire Science and Technology, Central Police University (C.P.U), he received his Ph.D degree from the School of Building Construction, University of Florida in U.S.A. at 1992, and has published a large amount of papers on different related fields of study. For instance, on 29th September 1999, he had published The Records of the USAID, US&R Task Force to Attend the 921 Earthquake Search & Rescue Operations. In 2001, he was invited to participate in 2002 Asia Oceania Symposium on Information Technology and Strategy for Earthquake Disaster Reduction in Tokyo, and presented the paper Overview and Analysis of the Disaster Information Management for Emergency Response of Local Government- Lessons Learned from 921 Chi-Chi Earthquake. In addition, he has also contributed to the research related to Tunnel Disaster Prevention and Emergency Reaction and Standard Operation Procedures in recent years, which the emergency response plan of the longest tunnel (the total length is 12.5 kilometer) in Taiwan was referred to his report. From all the above displays the fact that he has made much effort in his researches and has put these researches into practice to help improve the safety of the general public. Under the leadership of Dr. Hsiung, Make Taipei a Safer City – Strengthen the Disaster Prevention Networks project by Taipei City Fire Department was honored to receive the “Executive Yuan Quality Service Award” in 2009.

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The Needs and Challenges of Disaster Reduction for Taipei City

The Geological conditions of Taipei city are unfavorable; having main river streams stretching through the basin, sloping fields taking up the 55% of total land area (including residential buildings on slopes) and plain area that is highly developed (whilst high concentration of rainfall), the potentiality of soil and water disaster has become more and more severe. Moreover, Taipei as the heart of politics, economy and culture of Taiwan, its traffic system is maturely webbed, yet it is facing problems such as aging society and foreign caretakers regarding its social structure. When facing extremely grave disasters, it would be affected in a wide spectrum, thus its ability to function properly after disasters has become a challenge that awaits the test of time.

Recent years the Taipei city government has gradually completed the installment of several disaster prevention software and hardware, yet due to the growth in scale of power of natural disasters, and as the citizen's tolerance for disaster has abated, the benchmark of demand towards a governments' disaster relief capability has risen. Meanwhile we are fronting the impact of an information explosion era, and therefore to accurately and immediately react and process information has become a great challenge on disaster prevention and relief for local governments. And to overcome the aforementioned difficulties, we are working on a few measures and systems:

1. *Natural Disaster Computer Simulation Training System*：We have been developing a distributed multi-layer training system, rebuilding the "real" situation of disaster scene according to different disaster scale levels, scenario conditions, development of disaster, time sequence and role of participants to conduct integrated training, strengthening the scenario decision capability of commanding officers.

2. *Emergency rescue heterogeneous communication network*：The Taipei City EOC previously relied mostly on 119 voice report system to transmit data, but since its

amalgamation with the 1999 citizen hotline from 2008, it has been able to effectively distinguish between emergent and non-emergent sources of case reports. Also considering the widespread of wireless heterogeneous internet, the wireless internet integrated emergency rescue system should be adapted.

3. *Construct disaster GOC for vulnerable areas*：The city government can use Group Outbound Call (GOC) to increase the efficiency of mobility of government disaster relief units by ten times, and it can expand its services in the future, providing emergency alert of vulnerable areas.

4. *Develop radio channel, digital and integrated VoIP function exclusively to disaster prevention*：Currently the emergency rescue radio channels are used by the police, fire, medical, and military units separately, but because of each department's uniqueness, these channels cannot be connected. It would resolve the problem of not being able to communicate between channels, and no back up channel, by establishing a radio channel exclusive to disaster relief and meanwhile all departments should digitalize its radio system and integrate it with internet VoIP.

5. A*dvance disaster on-site visual transmission quality*：Taipei city currently has disaster scene on-site inspection visual transmission system (via Wifi, 3.5G, and Satellite), but due to different hardware conditions of telecom companies, the quality may vary from time to time. We would wish to see the development of the integrated mobile-networks module, so it may become one of the most economically effective visual transmission methods.

6. *Cross-department immediate disaster information gathering system*：In the future we will integrate the Police department's new "security electronic wall" surveillance system, enabling immediate visual access of disasters, providing the disaster response center commander with more reference

7. *Disaster prevention info based on the needs of general public*：The electronic media is prosper in our country, in addition, internet users tend to transport disaster news via BBS, twitter, plurk and facebook; it has the merit of alacrity, yet more or less causes the problems of overlap in information and difficulty to distinguish the credibility of source and context. Thus, we suggest developing disaster prevention information based on the publics' needs, and commission NGOs and NPOs to assist governments in processing the gathered information in order to elevate the efficiency and efficacy of disaster relief.

8. *Disaster Warning Radio System*：Imitating the national alerting system (J-alert) that Japan has been aggressively constructing within their nation, we will be constructing digital radio broadcast and monitoring poles in high potential of danger areas, which provides alerting broadcasts and two-way calling system.

9. *Promote proactive mitigation measures*：Some old building communities, not only affect the development of the city area as a whole, but also lack in safety and disaster resistance. Therefore, Taipei city will encourage "mid/low-rise old buildings" to be reconstructed through incentive plans. On the other hand, to abate the risk level of disaster, we suggest to publicize sensitive environment information, strengthen environment evaluation and monitor/maintenance mechanism, produce more elaborate disaster prevention maps, and to continuously promote disaster prevention insurance system.

10. *Increase the recovery ability of government and the general public*：When severe disasters occur, while the government manpower, resource, tap water, electricity, traffic system and roads, and all other life maintain systems are struck or defected, in order to ensure the continuing operation of public sectors or important facilities, the emergency respond measures must establish an order of different priorities so that the limited resources can be utilized most effectively.